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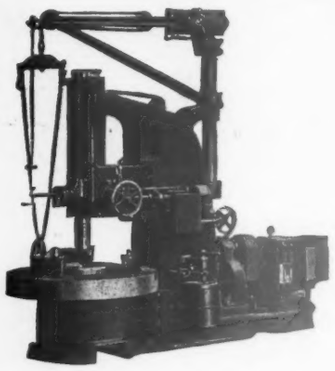

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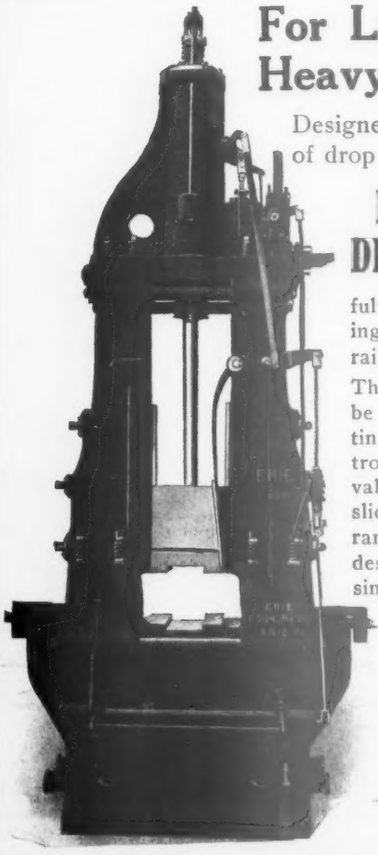

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Railway Mechanical Engineer

Volume 90 May, 1916 No. 5

Saving Weight to Provide Boiler Capacity

A great deal has been accomplished within the past two or three years in the way of reducing the dead weight of the machinery in a locomotive by the use of special steels. That there is still more to be attained is evident when we consider the changes which would be made possible by the use of different material in some of the locomotives now in service. Take, for example, a recent design of Santa Fe or 2-10-2 type locomotive. The substitution of alloy steel for carbon steel in the piston rods, crossheads and pins, side rods, crank pins and valve gear and the use of hollow driving axles would result in a reduction in weight of almost 5,000 lb. The use of the hollow axles alone would save in the neighborhood of 1,000 lb. The value of this saving in a direct way, aside from other considerations, will be seen when it is considered that if put into the boiler this extra weight would add fully two inches to its diameter. Looking at the matter of saving in weight from this angle shows in a very practical way the value of refinement in design in the increasing of capacity.

The Car Terminal Competition

The first prize in the car terminal competition, which closed April 1, was awarded to R. S. Mounce, general foreman car repairs, Erie Railroad, Jersey City, N. J. The article is published in the car department section of this issue. The judges awarded the second prize to J. E. Ross, master painter of the New Orleans, Mobile & Chicago at Mobile, Ala., whose article will be published in an early issue. There were a number of other articles received in the competition, most of which are suitable for publication either in whole or in part. Mr. Mounce's article should be of general interest. It describes the practice at the Erie Railroad's terminal at Jersey City, where a very large suburban traffic is smoothly and effectively handled under conditions made difficult by the physical characteristics which have necessitated the present layout in increasing capacity. If a car terminal could be laid out under ideal conditions as regards distance from the passenger station, track room, repair facilities, etc., the problem of caring for the large number of cars which are daily cleaned and repaired at Jersey City would be a comparatively simple one. The principal value of Mr. Mounce's article lies in the fact that it describes the practice that is in daily successful operation in a terminal where the conditions are not ideal.

Cleaning Passenger Cars

It is doubtful if the average car foreman or car cleaner fully realizes the value to his company of cars thoroughly cleaned inside and out. Many of these men do not ride in regular passenger trains to any extent and consequently they are not familiar with the attitude taken by the traveling public. The road that neglects the cleaning of passenger cars in order to save mechanical department expense is providing decidedly poor advertising for the traffic department. No other single item has as much direct effect on the passenger's opinion of a railway as the condition of its passenger equipment. This does not apply simply to the inside of the car. If the outside is dirty it produces a bad effect in the mind of the passenger before he enters the train, and he is then likely to look for and comment unfavorably on things which he might otherwise have overlooked. We have frequently called motive power men to account for being motive power men and not railroad men. This is a case where the car department has a chance to show that its employees are not simply car department men but are railroad men, who will take into consideration the work that has to be done by officers of the traffic department in creating business which may very easily be lost by laxity on the part of the car department. If a neighboring road has clean cars, no matter how nearly alike the service on the two roads may be in other respects, the road with the clean cars is likely to get more of the business than the one which neglects the matter of cleanliness.

The Fireman and Boiler Capacity

It took locomotive designers some time to realize that a locomotive's capacity depended mainly on the boiler, but since they have realized it they have taken adequate steps to provide locomotives with ample steam making facilities. With the growth of the locomotive the size of the boiler has increased to such an extent that it has overreached the limitations of hand firing and the mechanical stoker has been a necessity in many cases. In fact, there is little question but that there are locomotives now in service from which the maximum capacity is not being obtained because of its being impossible to obtain this capacity with hand firing. This has been pointed out previously by L. R. Pomeroy in remarks made before the New York Railroad Club. An ordinary rate of evaporation for a locomotive is 10 lb. of water per square foot of heating surface per hour; this may reach 12 lb. for short intervals but the probability is that in average service not over 7 or 8 lb. is being attained. A fireman cannot be counted on to fire continuously over 5,000 lb. of coal per hour. If we consider a locomotive with 4,500 square feet of heating surface, the total evaporation per hour at the rate of 10 lb. will be 45,000. At 6 lb. of water per pound of coal, the coal necessary to produce this evaporation would be 7,500 lb. per hour, which is well above the limit for hand firing. It would seem that there are a good many cases where locomotives, both passenger and freight, are not delivering the output which was expected of them and in which the steaming qualities of the engine are blamed for the trouble when in reality the difficulty lies in the inability to obtain the full capacity by handfiring. When a locomotive is equipped with such a large boiler there should be sufficient foresight brought to bear on the subject to insure the development of all the power possible. The mechanical stoker is capable of firing coal at any rate at which the present day firebox can burn it

and if large locomotives are required to obtain maximum train loads it is no economy to hand fire them if by doing so their full capacity cannot be attained.

Specializing Enginehouse Work

Many of our contributors on engine house subjects lay considerable stress on the value of having specialists for the different classes of work in the enginehouse. There can be little doubt as to the value of organizing an enginehouse force in this way, particularly if the terminal is a large one. The man, or gang of men, who attends to nothing but electric headlight repairs very soon becomes expert in the determination of what is wrong with this equipment and what should be done to remedy it. Air brake work has long been specialized and it is probable that the desirability or even necessity of having experts in air brake work led to the extension of the practice as terminals increased in size and the locomotives became more complicated. One class of work that should be taken care of by specialists wherever possible is the reducing and fitting of main rod brasses. If this work is assigned to men who do nothing else except in cases of emergency they become so expert that it will be found that trouble from heating at either end of the rod will be greatly reduced, if it is not entirely eliminated. While the practice of specializing the work is not so readily carried out in the small engine house it is possible even there to obtain very satisfactory results by assigning to one man two or three lines of work that are closely allied. Of course, the men who are assigned to special work should be good all-round mechanics in the first place, but by careful selection of the men and due consideration of the class of work for which they are best fitted, better results can be obtained in almost any engine terminal by specializing the work than by the indiscriminate assignment of all the mechanics to all classes of work.

England's Idea of the Steel Passenger Car

From the experience the railroads have had in this country with the public demand for all-steel passenger cars, it is hard to understand that the English people can have the objections to this type of equipment as expressed recently in The Engineer of London. That publication states:

"The all-steel vehicle is an unsatisfactory ideal. It is difficult to construct, is not easily decorated and is very susceptible to climatic changes. Steel coaches are understood to resist better the evils of collision and derailments, but they are not without objections that are not found in wooden stock. One does not relish the idea, for instance, of having to be rescued from an all-steel car by an oxy-acetylene blowpipe cutting the sides of the carriage open. The rendering of wood non-inflammable is a better idea, etc."

First, The Engineer calls attention to the difficulties met in the decoration of the steel cars. Notwithstanding these difficulties, however, the American railroads are today producing steel cars as handsome, we venture to say, as any of the wooden cars in use in England. Their susceptibility to climatic changes has been amply taken care of by our insulating engineers. The item referred to passes over lightly the advantages the steel car has in collisions and derailments, indicating that it is far more desirable to be rescued from a wreck by means of a hatchet than the oxy-acetylene blowpipe. Our English contemporary evidently forgets the fact that the need for rescue has been very materially reduced by the adoption of steel equipment, and further, that this steel equipment is so carefully designed that, even in the case of accident, seldom, if ever, will the oxy-acetylene blowpipe be found necessary to rescue passengers. We are satisfied with the steel equipment. We know it is a good thing. Our engineers have met the problems raised by the introduction of this equipment in an able manner. That the English public, and especially the English engineers, are not in accord with the idea of steel cars is possibly due to the fact that the designs of and methods of constructing our steel equipment have not been as carefully studied and analyzed as they might have been.

Altering Locomotive Front Ends

When a locomotive is reported as not steaming the first move made in the roundhouse is to examine the front end and if there are no leaks or other plain indications of the cause of the trouble either the nozzle is reduced or the diaphragm shifted. It is well known where such indiscriminate "fooling" with front ends leads. There are many roads on which it is doubtful if two locomotives of the same class have the same front end arrangement; the locomotives have been changed in one way at one terminal and in another way at another terminal. A bridge is put in the nozzle at one engine house and is taken out and the diaphragm shifted at the other end of the run. Some of the roads that have gone into an extensive program of fuel economy have found it necessary to restandardize the front end arrangement of practically all of their locomotives. There must, however, be a prohibition placed on indiscriminate front end alterations if this work is to have any effective results or if new locomotives are to develop their full effectiveness. There was a time when little or nothing was known about front end design and it may have been justifiable at that time to let every master mechanic and engine house foreman work out his own ideas regarding the drafting of locomotives, but there is now sufficient definite information available to guide the designer in determining on a front end arrangement that should result in a free steaming engine. If adjustments or alterations are afterwards found necessary they should be made under the direction of a mechanical department officer who will investigate matters deeply enough to be sure what condition needs correcting and then see that the correcting is done in a manner that will not tend to completely demoralize the standard front end arrangement of all locomotives on the system.

Railway Mechanical Conventions

With the month of May the various mechanical department associations begin holding their annual conventions. Some of these associations are well supported by the representatives of the different roads, while others do not have the support they are entitled to. This is not always the fault of the members of the associations, as in several instances the roads by which they are employed refuse them transportation and the time for attending the conventions. A review of the work done by the associations, especially in the past few years, should make it plain to the mechanical department officers that a large amount of good constructive work is being accomplished by these associations. Further than this, the benefits derived by the men in meeting and becoming acquainted with fellow craftsmen, and the interchange of personal experiences during the convention period, are of decided advantage to both the men and their employers. It broadens the men and fills them with new ideas and an enthusiasm which will have its good effect on the work when they return to their shops or offices. The duties and responsibilities of the minor mechanical officers are constantly increasing. The "stay-at-home" man cannot pretend to meet these conditions adequately. The men must broaden out. They must be educated, and the annual conventions offer an excellent means for this education. If the officers in authority will view the matter as one of investment and send their subordinates to conventions with instructions

to give as much as they can and absorb all that they can, the work of the associations will still further increase in value and the men and their companies will be greatly benefited.

The Responsibility of Car Inspectors

In writing to the editor of the Railway Age Gazette, a car foreman compares the duties of the locomotive engineer, the conductor and the car inspector. The latter is responsible to a large extent for the safety of human life and property. In the matter of responsibility his duties rank high even when compared with those of the man in charge of the operation of a locomotive and the knowledge required of him is at least as great as that possessed by the average locomotive engineer of today, even with the considerable difference in the salaries paid. But the car inspector is not always in full realization of the responsibility which rests upon him and this is a point which we do not feel has been brought out as strongly as it might be in the various discussions on the car inspector and his duties which we have published in the past few months. The foreman in charge of the inspector may have a full realization of the responsibility which rests on himself and through him on his inspector, but unless the inspector himself realizes this responsibility he will not be as effective as he should be. We have known car inspectors to deliberately neglect the repair of slight defects which they must have known were dangerous and who did not hesitate to let cars go out in such condition. If a car inspector is to live up to what is, or at least should be, expected of him, he not only should possess a very complete knowledge of everything pertaining to his work, but he should be brought to realize to the fullest extent that on him rests the responsibility for determining not simply whether a car is fit to run but whether or not it is in such a condition that it can safely carry passengers or freight.

Getting the Most Out of Locomotives

The longer a locomotive is kept in service the more it earns for the railway. This does not mean simply that if a locomotive is turned out of a shop at a certain time and is not returned to the shop for repairs until a month or two months after the regular shopping time it has fulfilled its duty as a contributor to the company's earnings. The locomotive may have been out of service for considerable periods during this time for heavy roundhouse repairs or it may have been a large contributor to the total of the road's engine failures, in either of which cases it is falling short of accomplishing its maximum as an earner. A locomotive should be kept in service as long as possible, provided excessive running repairs are not required in order to accomplish this, and also that this extra period of service is not purchased at the expense of a demoralization of traffic because of engine failures. The condition which should be striven for is the turning out of locomotives which have undergone general repairs in such good condition that they are capable of maximum performance without failure for the greatest length of time. Such results obtained from locomotives give the company a maximum return for the money invested in motive power and to obtain them does not necessarily require that the road expend more per engine for repairs than a neighboring road or than is spent by the average road. But it does require that the general repairs be carried out in the best manner possible and that no running repairs be neglected. Finally, the effectiveness of repair work depends very largely on the shop organization and equipment. The matter of equipment applies particularly at the present time on many roads which have added to their motive power considerable numbers of large engines which are beyond the capacity of the road's engine house and shop buildings and machine facilities. There is too little being spent on facilities for the upkeep of modern locomotives and the saving in capital expenditure so realized is being felt as an increase in operating expenses.

NEW BOOKS

Corrosion of Iron.—By L. C. Wilson. Bound in cloth. 169 pages, 4¾ in. by 7¼ in. Published by The Engineering Magazine Company, 140 Nassau street, New York. Price $2.

This book is a revision of a series of articles recently published in The Engineering Magazine. The author's purpose has been to assemble and condense the most interesting and important studies and facts connected with the corrosion of iron and its protection therefrom. Considerable practical information is included concerning materials available for the preservation of iron and steel.

Scientific Management and Labor. By Robert Franklin Hoxie, associate professor of political economy, University of Chicago. Bound in cloth. 302 pages, 5 in. by 7½ in. Published by D. Appleton & Co., New York. Price $1.50.

Generally speaking, through improvements in industrial processes and elimination of wastes in the expenditure of labor scientific management is designed to serve the interest of employers and workmen alike, as well as society at large. That in many respects it has accomplished much toward this end cannot be denied. It has standardized facilities and processes, and has brought about co-ordination of effort where little better than confusion existed before. In its methods of dealing with labor, however, it has generally failed to win confidence, either because of the blind prejudice of organized labor or a lack of appreciation of the complexity of the labor problem. With the claims of the advocates of scientific management as to its relation to labor and those of the labor leaders, directly opposed to each other there has been practically no reliable information available from which an unprejudiced opinion on the merits of the controversy could be formed. Primarily to test the validity of these opposing claims as brought out at the hearings on scientific management held by the United States Commission on Industrial Relations in April, 1914, the author was commissioned to conduct a thorough investigation of the relations of labor to scientific management as they have developed in the operation of the three generally recognized systems.

The present volume contains the conclusions of the author based on the results of this investigation. The points at issue were carefully analyzed and a comprehensive study was made of scientific management as it was found in actual operation in 35 shops and other concerns. Care was taken throughout the investigation that it might be entirely impartial and to this end the author was assisted by a representative of employing management and a representative of labor, both of whom have fully approved the author's conclusions. In a number of appendices at the close of the volume are contained detailed statements of the labor claims of the three principal exponents of scientific management and the trade union objections to the system, together with a statement of the vital points at issue. The volume closes with the text of an elaborate questionnaire by the use of which most of the facts were obtained.

This volume is a valuable addition to the literature on scientific management and cannot fail to prove of great interest to all who are in any way concerned in the administration of the system, as well as to shop managers generally. The extravagance of the labor claims which have been made for scientific management is clearly indicated, some of them being inherently opposed to the system employed. It is also evident that there has been a disregard for the human element in all its complexity, throughout the system. Notwithstanding the numerous defects, however, "it is to date the latest word in the sheer mechanics of production and inherently in line with the march of events."

COMMUNICATIONS

A WORD FOR THE EFFICIENCY ENGINEER

TO THE EDITOR:

I have been greatly interested in reading the article in the December issue of the *Railway Age Gazette, Mechanical Edition*, entitled "How the Old Man Beat Him to It."

It would appear that Mr. Wolcomb has invaded the realms of fiction in his endeavor to parade "Old Dan" Keefe as a hero in the modern novel of "How the Old Man Beat Him to It"; he has relegated the efficiency engineer to the role of a dire villian, whose main object appears to be to get "Old Dan."

The primary theme, however, is predicated upon a fallacy, as the aim of an efficiency engineer, shop betterment specialist, or what not, is not the supplanting of present organization unless unresponsive, but rather the discovery of points for betterment, directing attention to them and aiding in their improvement. Efficiency is not magic, but is simply another term for common sense applied to the attainment of economy in the operation of shops and in the use of materials. Efficiency is the best attainable and can only be secured through comparative analysis.

The successful efficiency engineer is he who, not as Mr. Wolcomb leads us to believe, looks for opportunities to make radical alterations in equipment and facilities at a large expense, but rather for the best use of the facilities available and the improvement of these facilities at a slight cost. The efficiency engineer who did not have the power of analysis to recognize the reasons, which "Old Dan" was keen enough to perceive, as to why the patternshop should not be located immediately adjacent to the foundry, would be very weak. The economy of installing an electric crane in an old shop is questionable; those familiar with shop operation know that the time required to wheel or unwheel an engine with a long drop table or an electric crane is about the same. This by no means depreciates the value of a traveling crane, as it would be considered the height of folly to omit such equipment in a new building. Its use, however, may be questioned where old buildings must be adapted to receive a crane.

The same reasoning holds with motor drive for machine tool equipment. While highly desirable, no justification can be found for a wholesale installation of individual motor drive. Yet examples might be found where certain large machines and ones frequently called upon for overtime service could economically be so equipped, while in the main, if found desirable and economical to use electrical equipment, restricted group drive would be far more advantageous.

Again, does it seem conceivable that an efficiency engineer who really could claim such standing would be so inappreciative of fire hazards as to wander through a pattern shop smoking? Would he also be so lacking in tact and the appreciation of his co-operative function as to first look over a prospective field without making his presence known, explaining his mission and endeavoring to pursue his calling in harmony with the local organization?

Would be overlook the most important of all, the distribution and handling of material? It is the customary function of a shop betterment engineer to give this his first and careful attention, as without betterment in this respect no permanent improvement may be expected in the material costs.

Concerning the construction of machines instead of purchasing, an extremely questionable field of economy is entered. Shop kinks and jigs are of inestimable value, as is attested by the efforts directed by an efficiency engineer to their design and use, with substantial encouragements offered in efficiently operated plants for suggestions made by workmen. When, however, the field of the machine tool builder and designer is trespassed upon, it is severely to be criticised. There is hardly a railroad shop in the country, perhaps, but could furnish one or two examples of misdirected efforts in this respect. Frequently, if all the misapplied costs entering into its construction could be ascertained, it is probable that its expensiveness would be self-evident, not to consider the greater cost of production.

And in conclusion, it is self-evident why "Old Dan" beat him to it, as Mr. Wolcomb's efficiency engineer has only the name to justify his profession, lacking a very essential qualification required to fit him for such an occupation: *i.e.*, an appreciation of the necessity for a systematic and co-operative co-ordination of purpose toward the attainment of improved and economical shop operation. MECHANICAL ENGINEER.

THE MECHANICAL DEPARTMENT CLERK

WINNIPEG, Man.

To the Editor:

Referring to the communication in your April issue by A. C. Clark on The Mechanical Department Clerk. It would appear that the mechanical department clerk was giving something for nothing, whereas in reality, although he may be underpaid on a general average for what he does, he usually is getting a training that fits him for some other position. My experience may not be long enough perhaps to be representative, but I have been in a good many mechanical department offices and my observation is that, outside of the chief clerk, the rank and file of the office is composed entirely of young men who are drawing more money than they would had they been learning a trade. It is true also that these young men, as soon as they realize that they cannot pass a certain limit, take the first opportunity to better themselves elsewhere, and, judging from the appearance of our offices generally, it does not appear that to do so is very difficult.

Is not every job a "blind alley" job, unless we make it otherwise? It is said of the man who is left behind, that his responsibilities have raced ahead of his salary with his increasing years. This may be quite true, but in most cases the reason if traced will be found in the individual rather than in the job. A job may be practically the same for twenty years, and the same man may be at it, unless he makes the move or unless the company moves him. Competent men get advanced to other positions or else they advance themselves elsewhere. Some competent men lack the necessary spirit to make the break with a company which at least gives them the security of a steady, if small, income for fear that the new job with the smaller concern may not be suitable to them. It is this class, I take it, that our friend refers to as the "competents in a blind alley," and there is no doubt that there should be some better system of recognizing such faithful service as these men give on every railroad.

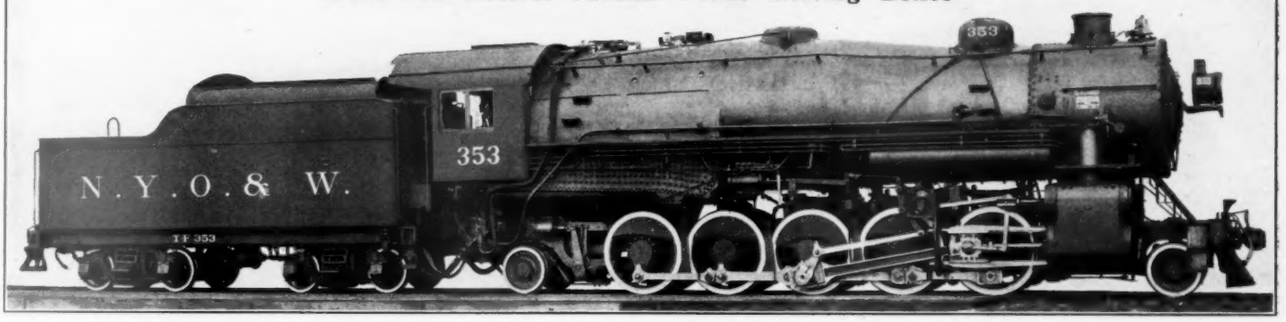
Various schemes are being used by different companies to help this situation and with varying success according to the application. The practice of having the department chiefs send in periodic staff recommendation sheets for the purpose of advancing deserving men to positions in other departments, appeals as being in the right direction. Other roads try to discover the unappreciated employee of merit by means of special service investigators, these latter being doubly useful in also finding ineffectual service.

While each of these systems has its merit, it cannot be overlooked that there is always the human element factor behind it all. There is always someone overlooked and always someone jumped ahead unfairly, at least so it appears. In the case of the mechanical department clerk, his scope is as wide as any other employee's. Under a broad system of advancement such as above mentioned, he can take a position in other departments with increased salary accordingly as his capabilities are recognized.

A SHOP ENGINEER.

LOCOMOTIVES OF THE SANTA FE TYPE

Two Recent Engines with 2-10-2 Wheel Arrangement and Lateral Motion Front Driving Boxes

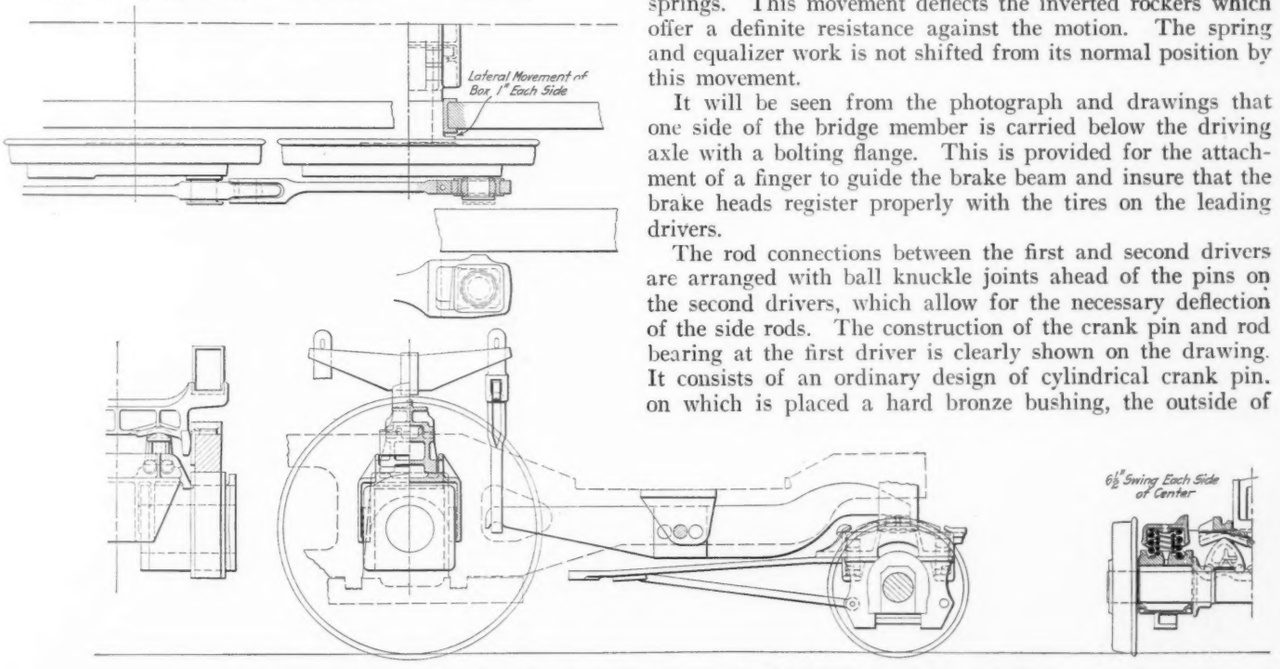


New York, Ontario & Western 2-10-2 Type Locomotive with Lateral Motion Driving Boxes

THE American Locomotive Company has recently delivered 12 locomotives of the 2-10-2 type to the New York, Ontario & Western and five to the Erie Railroad, the leading axles of which are fitted with patented lateral motion driving boxes. The 2-10-2 type has been handicapped by its long, rigid wheel base and the application of the lateral motion driving axles was made to keep the rigid wheel base within limits commonly met with on smaller types, at the same time securing the advantages of the increased capacity which may be attained with the ten-coupled wheel arrangement.

The lengths of rigid wheel base shown in the table are well within the figures used on a very large number of Mikado and Consolidation type locomotives in service throughout the country.

	Driving wheelbase	Rigid wheelbase
N. Y. O. & W.....	20 ft. 0 in.	15 ft. 0 in.
Erie	22 ft. 6 in.	16 ft. 6 in.

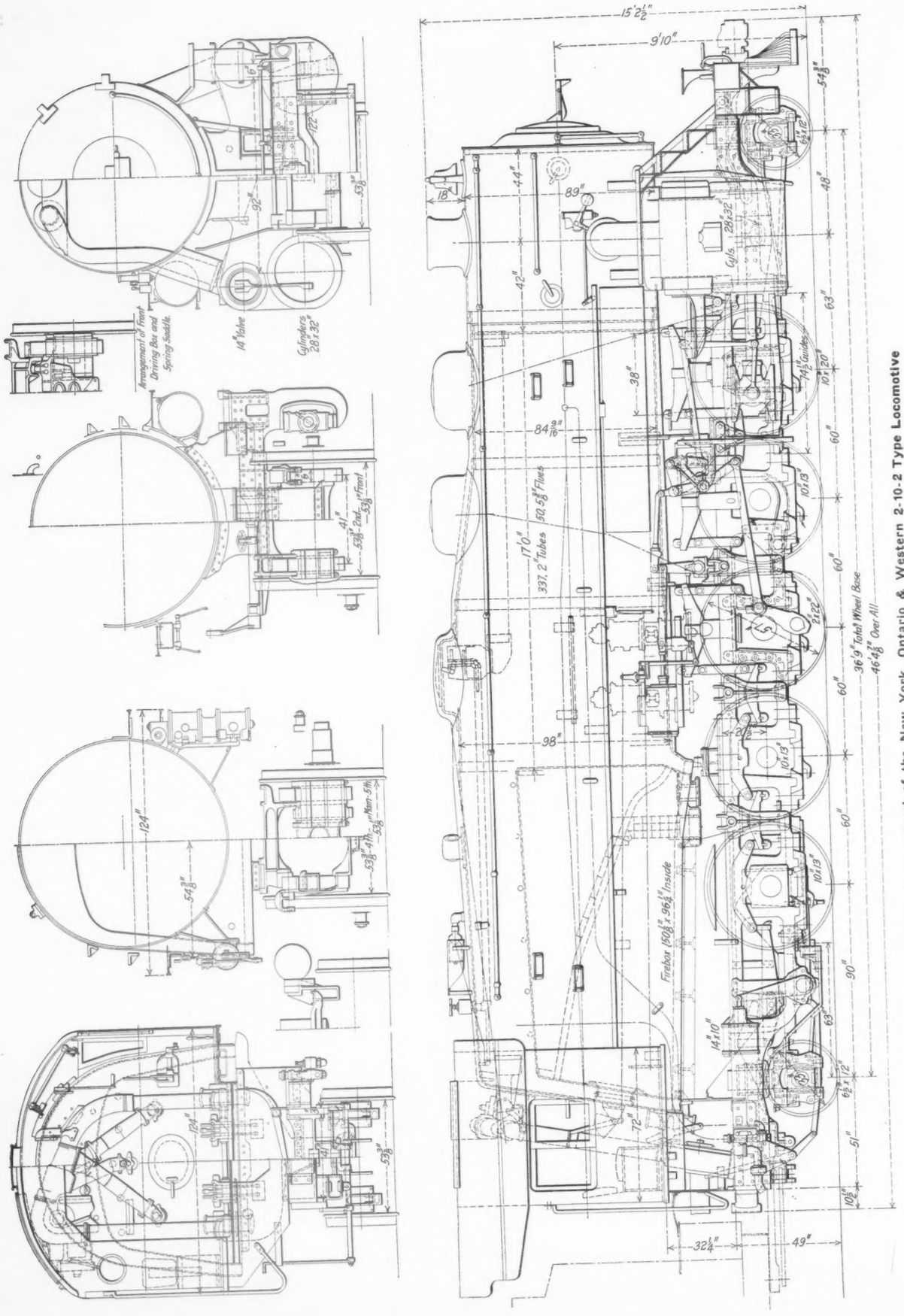


Arrangement of the Lateral Motion Journal Boxes and Flexible Side Rod Connections

The lateral box arrangement consists of two independent driving boxes, whose lateral centers are about on a line with the inside of the main engine frames. These two driving boxes are held in a fixed relation to each other by a bridge or spacing member which engages the inner flanges of the boxes. The weight, which is transmitted through this bridge member, is applied to the boxes on their transverse centers. The lugs which engage the inner flanges of the boxes are for the sole purpose of maintaining the proper spacing of the boxes and do not transfer any vertical load. The driving springs are in about the normal position and are carried on a cross member which has a vertical movement only between the engine frames, a wearing shoe being placed upon the inner side of the main frames to prevent side motion. Between this cross member and the bridge are interposed two inverted rockers designed so that a lateral force equal to 20 per cent of the weight transmitted is required to deflect them from their normal position. When the boxes are deflected from their normal central position by a side movement of the first pair of driving wheels, the boxes and the bridge casting are moved laterally relative to the member carrying the springs. This movement deflects the inverted rockers which offer a definite resistance against the motion. The spring and equalizer work is not shifted from its normal position by this movement.

It will be seen from the photograph and drawings that one side of the bridge member is carried below the driving axle with a bolting flange. This is provided for the attachment of a finger to guide the brake beam and insure that the brake heads register properly with the tires on the leading drivers.

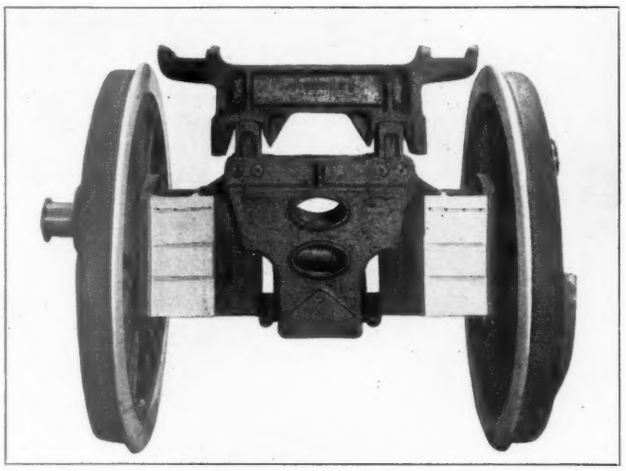
The rod connections between the first and second drivers are arranged with ball knuckle joints ahead of the pins on the second drivers, which allow for the necessary deflection of the side rods. The construction of the crank pin and rod bearing at the first driver is clearly shown on the drawing. It consists of an ordinary design of cylindrical crank pin, on which is placed a hard bronze bushing, the outside of which is turned to a spherical surface. Encasing this bushing are two pieces of hard steel which are held in place in the rod end with a wedge in the same manner as two ordinary brasses. The bushing can revolve either on the crank pin



General Arrangement of the New York, Ontario & Western 2-10-2 Type Locomotive

or within the two steel pieces. When the rod is deflected from the normal position, the spherical bushing allows the parts to rotate sidewise around the center of the front crank pin; at the same time the bushing can revolve on the cylindrical portion of the pin. Several oil holes are provided through the bronze bushing to insure lubrication of both the spherical and cylindrical surfaces.

The operation of the lateral motion axle should be considered in connection with the engine truck. The driving



Lateral Motion Device Assembled on the Axle

springs of the first and second axles are equalized in the usual manner with the engine truck; therefore, the weight on the engine truck center pin and the lateral motion boxes on the first axle is divided in proportion to the arms of the front equalizer. The engine truck is of the inverted rocker type, having a resistance of 50 per cent against the initial movement, and, as previously stated, the resistance of the lateral device at the first driver is 20 per cent. These resistances are so chosen in relation to the weight coming upon each centering device that the lateral resultants at the engine truck and first driver are about the same in amount. It will thus be seen that in effect the engine truck and the first driver act in practically the same way as a four-wheel engine truck in guiding the front of the locomotive, except that the lateral resistance is applied in the plane of each wheel instead of being applied midway between the wheels and divided between them as in the case of a four-wheel truck. As far as guiding the engine is concerned, therefore, the arrangement is very similar to a four-wheel application with the rear wheel of the truck acting as a driving wheel.

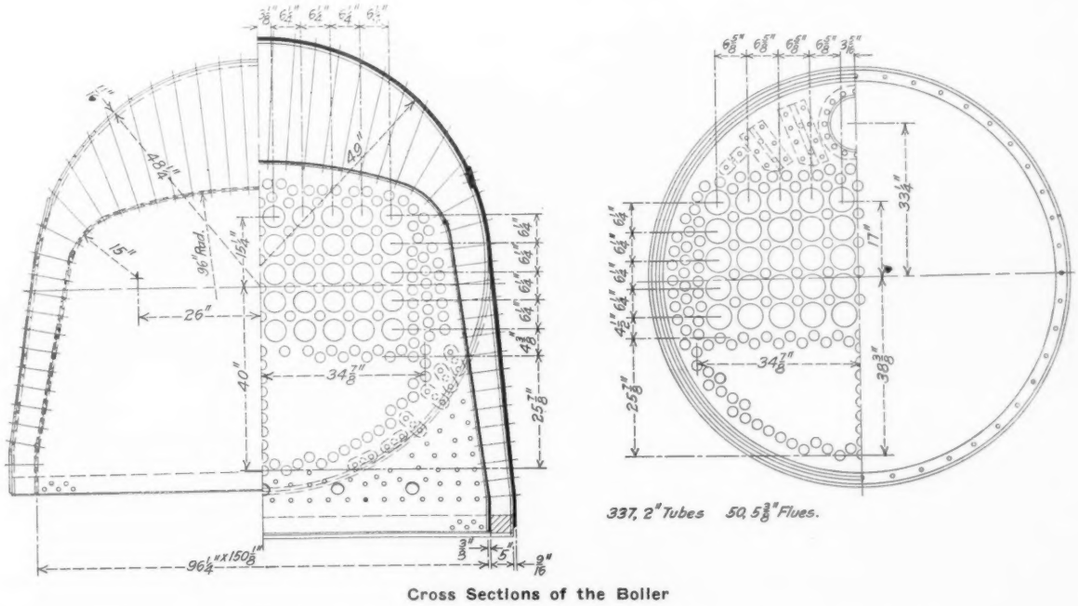
The resistance of the lateral motion box is proportioned with the idea of providing enough initial resistance so that for any ordinary road service on tangent track or curves the first driver will remain in normal position, and will deflect only when passing through turnouts and yard curves. The operation of the device in service has clearly demonstrated the correctness of the design in this particular. A close inspection of the engines in operation discloses the fact that the lateral motion driver very rarely deflects when the engine is running on the road. When the locomotive passes through sharp turnouts or is operating in yards, the lateral motion driver will deflect, thus preventing the cramping of the driving wheel base in the curve and limiting the pressure upon the driving wheel flanges.

It should be noted that the action of the rockers provides a limit to the lateral pressure which can be placed upon the first driving wheel flange. When this lateral resistance exceeds 20 per cent of the weight carried upon the lateral motion rockers the boxes will deflect, the excess lateral pressure being then transferred to the second driver, thus dividing the work of guiding the engine through curves between the truck and the first and second drivers instead of the truck and the first driver only, as in the ordinary ten-coupled arrangement.

The lateral motion driving boxes can also be applied to engines having four-wheel trucks.

In the ordinary design of 2-10-2 type locomotive, about 80 per cent of the total weight of the engine is on the drivers. It is therefore interesting to note the increase which has been obtained on these new engines, as shown in the table:

	Total Weight	Weight on Drivers	Percentage
N. Y. O. & W.	325,500	293,000	83.2
Erie	401,000	335,500	83.7



Cross Sections of the Boiler

Careful attention was given to the boiler design, and the boilers of both engines have the advantage of short tube length and large diameter. A short tube length not only gives greater evaporative value per square foot of heating surface, but also reduces back pressure and consequently increases the power of the engine. Large boiler diameter

combined with short tube length gives a large volume of water where the evaporative value is the highest.

The distance is short from the rear wheel to the draw bar in both engines. This not only makes the engine ride easier on curves, but it reduces the friction between the flange of the wheel and the rail.

The engines are equipped with superheaters, a combination Gaines and Security arch, Street stokers, Baker valve gear, Ragonnet air reverse gear, Chambers throttle valve, Economy front and rear trucks, and vanadium cast steel frames.

The following table gives the principal dimensions and data for both engines:

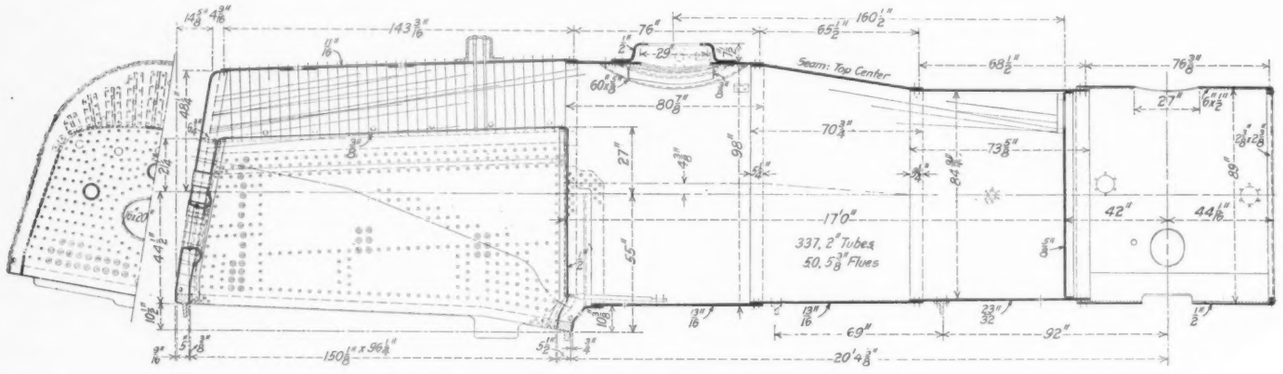
General Data	Erie, 2-10-2	New York, Ontario & Western, 2-10-2
Gage	4 ft. 8½ in.	4 ft. 8½ in.
Service	Freight	Freight
Fuel	Bit. coal	Bit. coal
Tractive effort	83,000 lb.	71,200 lb.
Weight in working order	401,000 lb.	352,500 lb.
Weight on drivers	335,500 lb.	298,500 lb.
Weight on leading truck	34,000 lb.	30,000 lb.
Weight on trailing truck	31,500 lb.	24,000 lb.
Weight of engine and tender in working order	585,000 lb.	521,200 lb.
Wheel base, driving	22 ft. 6 in.	20 ft.
Wheel base, total	40 ft. 3 in.	36 ft. 9 in.
Wheel base, engine and tender	71 ft. 9½ in.	66 ft. 10 in.

Ratios		
Weight on drivers ÷ tractive effort	4.05	4.21
Total weight ÷ tractive effort	4.83	4.95
Tractive effort × diam. drivers ÷ equivalent heating surface*	760	677
Equivalent heating surface* ÷ grate area	72.4	75
Firebox heating surface ÷ equivalent heating surface*, per cent	4.97	5.42
Weight on drivers ÷ equivalent heating surface*	48.8	49.7
Total weight ÷ equivalent heating surface*	58.4	54.2
Volume both cylinders	27.9 cu. ft.	22.7 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	246	264
Grate area ÷ vol. cylinders	3.4	3.5

Cylinders		
Kind	Simple	Simple
Diameter and stroke	31 in. by 32 in.	28 in. by 32 in.

Valves		
Kind	Piston	Piston
Diameter	16 in.	14 in.
Greatest travel	6½ in.	6¾ in.
Outside lap	1 in.	1 1/16 in.
Inside clearance	1/16 in.	
Lead in full gear	3/16 in.	⅛ in.

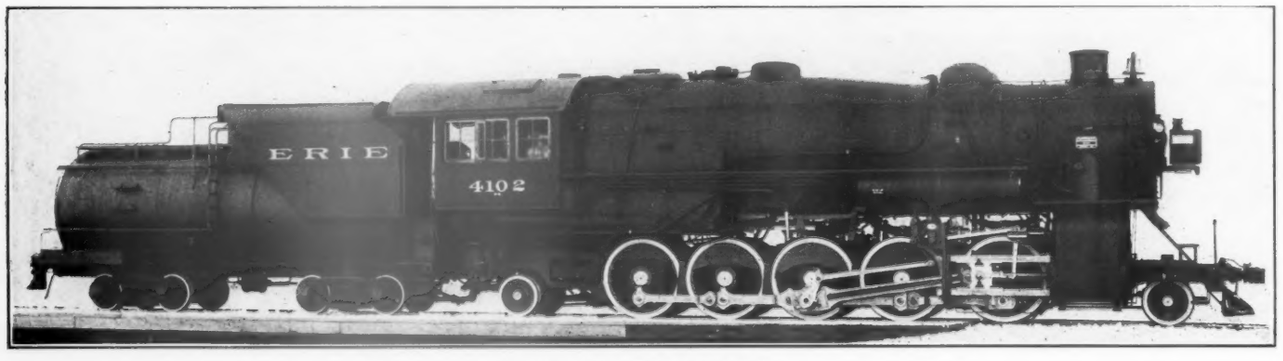
Wheels		
Driving, diameter over tires	63 in.	57 in.
Driving, thickness of tires	7 in.	7 in.
Driving journals, main, diameter and length	13 in. by 22 in.	12 in. by 22 in.
Driving journals, front, diameter and length	11 in. by 19 in.	10 in. by 13 in.
Driving journals, others, diameter and length	11 in. by 13 in.	10 in. by 13 in.
Engine truck wheels, diameter	33 in.	33 in.
Engine truck, journals	6½ in. by 14 in.	6½ in. by 12 in.
Trailing truck wheels, diameter	33 in.	33 in.
Trailing truck, journals	6½ in. by 14 in.	6½ in. by 12 in.



Boiler of the New York, Ontario & Western Locomotive

Boiler		
Style	E. W. T.	E. W. T.
Working pressure	200 lb. per sq. in.	190 lb. per sq. in.
Outside diameter of first ring	92⅛ in.	86 in.
Firebox, length and width	160 in. by 108¼ in.	150⅛ in. by 96¼ in.
Firebox plates, thickness	Crown, sides, back, ⅜ in.; tube, ⅝ in.	Crown, sides and back, ⅜ in.; tube, ½ in.
Firebox, water space	6 in.	Front, 5½ in.; sides and back, 5 in.
Tubes, number and outside diameter	317—2¼ in.	337—2 in.
Flues, number and outside diameter	60—5½ in.	50—5⅜ in.
Tubes and flues, length	17 ft.	17 ft.
Heating surface, tubes and flues	4,617.5 sq. ft.	4,173 sq. ft.
Heating surface, firebox	† 341.6 sq. ft.	† 325 sq. ft.
Heating surface, total	4,959.1 sq. ft.	4,498 sq. ft.
Superheater heating surface	1,274.2 sq. ft.	1,007 sq. ft.
Equivalent heating surface*	6,870 sq. ft.	6,008.5 sq. ft.
Grate area	94.8 sq. ft.	80.2 sq. ft.
Smokestack, diameter	23 in.	21 in.
Smokestack, height above rail	16 ft. 3 7/16 in.	15 ft. 0½ in.

Tender		
Tank	Vanderbilt	Water bottom
Weight	184,000 lb.	168,700 lb.
Wheels, diameter	33 in.	33 in.
Journals, diameter and length	6 in. by 11 in.	6 in. by 11 in.
Water capacity	10,000 gal.	9,000 gal.
Coal capacity	19 tons	15 tons



The Erie 2-10-2 Type Locomotive

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

†Includes arch tube heating surface.

PREVENTION OF CORROSION IN PIPE*

BY F. N. SPELLER, PITTSBURGH, PA.

Casual observation will show very marked differences in the degree of corrosion of pipe in service. For instance, hot water heating systems and sprinkler systems show practically no deterioration in service after 25 years, while low pressure steam returns sometimes give trouble after 15 years' service or less. Galvanized pipe in hot water supply systems where the water is heated under pressure, lasts from about five years upwards, depending on the temperature and quality of the water and volume of flow. The last named condition is so severe on iron and steel pipe that many are compelled to use brass pipe, at a cost approximately ten times that of galvanized pipe. These few instances are the extremes, but are surely suggestive when we consider that in pipe carrying ordinary water under some conditions there is no apparent deterioration in a generation; whereas in other cases, the same grade of pipe is seriously damaged in a very few years.

Some years ago, when steel pipe was comparatively unknown and not fully developed, it was natural to question this material, but comparisons of the modern wrought iron and steel pipe in the same lines in service have shown beyond any question that where corrosion is found one material suffers on the average as much as the other.

It has been the custom of the writer to keep several service tests under way continuously for the past few years. One of the most recent to be completed may be described as an example of the method pursued in conducting such tests. Four standard grades of pipe of well-known manufacture were selected and four pieces of each taken at random and coupled together alternately so that the hot water passed through each sample at the same temperature.

DETAILS OF TESTS

Date installed—October 27, 1913.
Date removed—November 20, 1915.
Location—Hot water return line, Pennsylvania Building, Philadelphia.
Temperature of water—175 deg. Fahrenheit, average.
Amount of water—5,000 gal. per day for 600 days.
Method of installation—In form of box coil.

CORROSION MEASUREMENTS

Lot	Material	Sample Number	Depth of Pitting in Inches: Average of 10 deepest pits in each piece	Deepest Pit
A	Steel	1	.068	.094
A	Steel	2	.087	.124
A	Steel	3	.045	.050
A	Steel	4	.063	.074
B	Steel	5	.079	.104
B	Steel	6	.056	.094
B	Steel	7	.054	.065
B	Steel	8	.070	.081
C	Iron	9	.065	.073
C	Iron	10	.072	.097
C	Iron	11	.078	.105
C	Iron	12	.077	.080
D	Iron	13	.055	.075
D	Iron	14	.067	.112
D	Iron	15	.067	.078
D	Iron	16	.073	.090
A	Steel	General Average	.066	.085
B	Steel	General Average	.067	.086
C	Iron	General Average	.073	.089
D	Iron	General Average	.066	.088

Inasmuch as both materials have been found to fail in about the same time under the same conditions, and as both have shown practically no deterioration after many years under other conditions, it would seem that with a correct understanding of the fundamental causes of corrosion a practical solution of this problem should be possible. The author has devoted a considerable portion of his time for the past ten years to a study of the factors governing corrosion of pipe in service, and is writing this paper in order to open up a more general discussion of measures for its prevention.

The inside of pipe is subject to peculiar conditions not to be compared with external corrosion, and the inside surface is particularly vulnerable in that protective coatings are difficult to apply, therefore more liable to be defective.

Consider for a moment the situation in a hot water heating system and a hot water supply system where the temperature of the water is about the same. It is evident that the water alone is not responsible for the results observed, but rather something brought in with the water. The hot water heating lines have started to rust and then the action has apparently stopped, while in hot water supply lines the action is continuous and rapid; so much so, that if the pipe does not fail by leaking it may be plugged up tight with the reddish hydroxide of iron. The only way to account for this accumulation of oxide of iron is through the oxygen in solution in the cold feed water, amounting to 6 to 10 cubic centimeters per liter according to the temperature and quality of the water. This very small percentage of oxygen is apparently the measure of the destructive power of the water and accounts for the fact that a limited volume of water has no serious action on iron, whereas when this water is renewed continually, especially when heated, the results are liable to be most disastrous. It will be useful to consider the mechanism of corrosion before discussing ways and means for preventing this action.

All water supplies carry more or less foreign matter in solution. What are usually considered the purest natural water supplies are generally saturated with oxygen and carbonic acid, which cause such waters to be very corrosive, particularly when heated. Iron in all its forms is soluble in water to the amount of a few parts per million, depending on its composition and that of the water. In this treatise, in referring to water in connection with corrosion, it will be understood to include domestic supplies of the usual degree of purity. Chemically pure water does not occur in nature, and therefore may be omitted from consideration.

The phenomenon of solution is now generally explained as an electrochemical reaction. When pieces of zinc and copper are connected and suspended in water, a current of electricity starts to flow through the water from the zinc to the copper. The zinc is termed the anode and the copper the cathode. While the current flows the zinc goes into solution, the amount dissolved being proportional to the current, according to Faraday's Law.

If we replace the zinc with a piece of iron, a current flows in the same direction and iron will be found in solution. Suppose we now replace the copper with another piece of iron. A small current of electricity will still flow, but not necessarily in the same direction, this depending upon the relative condition of the surfaces of the two pieces of iron.

It is this small current flowing between one piece of iron and another under water which causes iron to enter solution, and this is now recognized as the *initial reaction of corrosion*. Solution is hastened by carbonic acid and mineral salts in solution, as these make the water a better electrolyte. However, it has been proved that iron will dissolve to some extent in the purest water that has yet been made. If the iron is exposed to nothing but water this reaction will soon cease, due to the accumulation of hydrogen at the cathode causing polarization; and this is what actually happens in practice in hot water heating and other systems in which the water and consequently the supply of free oxygen is not renewed. On the other hand, when oxygen is present it combines with the hydrogen, depolarizing the surface of the iron and thus causing solution of the iron to continue. Oxygen enters further into the reaction by combining with the ferrous hydroxide to form insoluble ferric hydroxide, generally known as rust. With an unlimited supply of water and oxygen, corrosion will continue

* From a paper read at the January, 1916 meeting of the American Society of Heating and Ventilating Engineers.

until the iron is all converted into the form of ferric hydroxide.

So far most of the authorities are agreed as to the cause of corrosion, although there has been considerable scientific argument as to whether a trace of carbonic acid (CO_2) is necessary or not for the solution of iron. For all practical purposes we can let this question rest and combine the acid and electrolytic theories into one, as outlined above, which affords the best explanation of the observed facts available at this time.

Ever since the electrochemical theory of corrosion was proposed by Whitney in 1903 there has been a division of opinion as to the cause of the difference of potential observed between two pieces of iron. The majority at first assumed that this was due to variation in composition of the metal, and the manufacture of iron of a high degree of purity in the open hearth furnace was heralded with great expectations as to durability. So far, after several years of trial it has not been found that such iron is so well adapted for the manufacture of pipe as the grade of soft weldable steel now generally used for this purpose.

In the year 1904 the writer started a study of the potential differences as found on the surface of iron of various compositions, and has invariably found just as much difference in potential on the surface of very pure iron as on steel or wrought iron of ordinary commercial quality. Subsequent observations, covering several years of service with pure iron, open hearth and Bessemer steel and wrought iron of the quality required for the manufacture of wrought pipe, have confirmed the conclusion expressed by the writer after his earlier experiments, viz., that composition has very little to do with the rate of corrosion of these metals under water. It should be remembered, however, that conditions underground or inside pipe lines are not the same as when exposed to the atmosphere, so that these conclusions do not apply to materials subjected directly to atmospheric conditions, such as metal roofing, which is another problem.

The tests and experiments referred to indicate that differences in finish and density of the material, particularly the character of the mill scale and how firmly it is attached, usually determine where corrosion starts and how it proceeds. The difference of potential due to surface influences was found to be many times greater than that due to variations in composition in the ordinary run of steel, and predominated over all other influences in nearly every case. These conclusions were tested in the most critical manner and have since been borne out by service tests of several years' duration.

Among the surface influences which directed the course of corrosion it was found that rust, when once formed, was nearly as potent as mill scale in its effect on corrosion. Some recent work by Mr. James Aston, M. E. of the U. S. Bureau of Mines, confirms these conclusions, but goes further in showing that the influence of rust in some cases is to render the metal underneath the rust anodic. As the mill scale is always the cathode, there is every reason to believe that we may have in certain places on the surface nearly double the difference of potential which was expected and this without reference to the actual composition of the iron or variations thereof. Everything seems to point to this explanation of the cause of pitting as being the true one. Under some conditions of service in water lines or boilers it frequently happens that the tubes, which prove to be of a high standard of quality as regards chemical composition, structure and physical properties of the metal have rapidly pitted through in places. The difference of potential and the current which thereby flowed from the exposed places to the firmly attached mill scale, especially after the exposed metal becomes covered with rust, affords a satisfactory explanation of the rapid pitting observed in such cases.

The current flowing between two points on the surface of a piece of iron is very difficult to measure accurately, and it might seem at first that such currents are too small to cause serious damage. A rough calculation based on some experiments will indicate the ultimate result from such currents acting continuously with certain submerged areas of electrodes:

1 ampere acting for 6 months, will dissolve 10 lb. of iron, or a plate 12 in. by 12 in. by ¼ in. thick.

1 milli-ampere acting for 6 months, will dissolve .144 sq. in. of this plate, making a hole about 7/16-in. in diameter by ¼-in. deep.

0.1 milli-ampere acting for 60 months, will perforate this plate with a hole of the same size.

This rate of pitting is not so far different from that experienced under some conditions of service. The remedy seems to lie in the elimination of dissolved oxygen from water before use. This may be accomplished in practice in at least two ways:

1. By allowing the hot water to come to rest for a few minutes under greatly reduced pressure. As no reliable data could be found on the amount of oxygen retained in solution in water at various temperatures and pressures, a series of experiments were run to determine these constants. The results indicate that the pressure must be reduced below normal or the temperature raised nearly to the boiling point with the water at atmospheric pressure to get proper separation of oxygen and other gases.

2. An alternative method of reducing corrosion in water lines by satisfying or "fixing" the free oxygen was tried out by the writer several years ago, using clean iron turnings. It was found difficult to get the scrap free from oil, and after rusting had progressed for some time there was a tendency for the mass to cake together and so impede the flow. By using sheet iron, so formed as to provide a large number of channels with about ¼-in. clear passage through which the hot water slowly percolates, we expect that these difficulties will be overcome. The rate of rusting varies with the surface condition of the plates becoming more rapid as the surface is covered with a good coating of oxide. The speed of rusting is 50 per cent more rapid at 110 lb. per sq. in. pressure than at atmospheric pressure, and, of course, the time required to "fix" the free oxygen of the water varies with the amount of surface of metal exposed per cubic foot and other conditions which are liable to vary. For these reasons, the results obtained were only relatively correct.

On this principle, two small plants have been equipped to carry out this method of treatment in practice. These systems were installed at places where considerable trouble has already been developed through the clogging and corrosion of galvanized pipes. These plants, which have only been operating a short time, show a reduction of oxygen contents from 8 or 9 c.c. per liter to 0.1 to 1 c.c. per liter according to the rate of flow and temperature. At present it seems desirable to design the plant so that the oxygen contents will be less than 1 c.c. per liter at all times, at which point corrosion seems to be reduced to a negligible amount. Some more definite data on this point will be available after these plants have been in operation for several months. The indications are that the rate of rusting of the plates, and hence the efficiency of the apparatus, will increase with time. Water should be in contact with the plates for at least ten minutes.

Similarly, the corrosion of low pressure steam lines will be found to depend principally on the amount of oxygen which finds access to the system. The return lines naturally suffer the most and are usually the first to show failure. condensed water when freed from oxygen in solution is harmless, and will not even tarnish bright iron after months of exposure; but this water, on account of its great purity, has greater capacity for solution of oxygen than the average natural water and is therefore apt to be very corrosive when aerated. This may be prevented in large measure by using

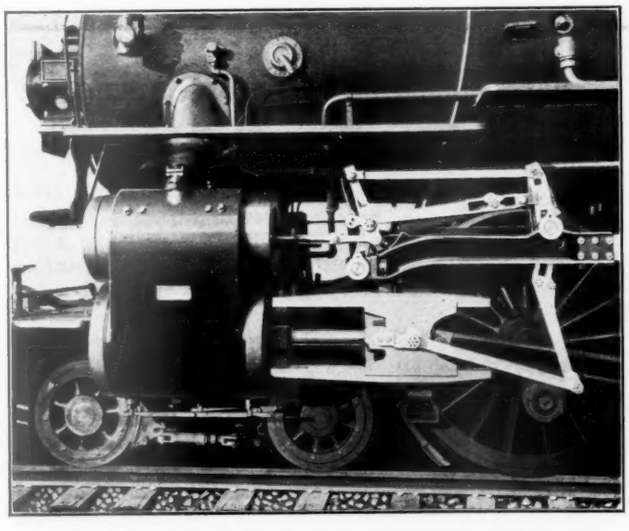
an open feed water heater and keeping the water over 185 deg. Fahrenheit.

In some cases the surface of the pipe may be protected with a film of oil deposited from the steam. The writer's attention was recently called to the satisfactory results obtained in some buildings using exhaust steam which on investigation was accounted for by the thin film of oil found on the inside of these pipes. This was such an interesting matter that we made some tests in the research laboratory on long lines of new pipe and found that mineral lubricating oil, when dropped into a pipe carrying steam under pressure at the rate of two drops per minute, was carried forward in a fine state of division and in a few minutes was found condensed in a uniform film in the pipe about 160 ft. from the lubricator. While this simple means of protection would perhaps be objectionable in some cases, there are many steam heating systems where the oil could do no harm and might result in considerably prolonging the life of the lines. Of course, nothing but a good grade of mineral lubricating oil should be used, and the supply should be regulated by a reliable sight feed lubricator.

Summarizing very approximately, the influence of various factors on corrosion, it appears from the experience we have at present that developments in the metallurgy and manufacture of steel pipe promise to add 50 or perhaps 100 per cent to the life of pipe compared with the service obtained under like conditions ten or twelve years ago. However, it appears well within the bounds of possibility to predict that de-aeration of the water, through the use of plants designed with this end in view, should at moderate expense increase the life of some piping systems four or five times.

TEST OF THE YOUNG VALVE AND VALVE GEAR

Comparative tests made by the Grand Trunk on two Pacific type locomotives of the same class, one equipped with Young valves and valve gear and the other with ordinary piston valves and the Walschaert valve gear, show a creditable performance for the Young valves and valve gear. This gear, which was described in the *Daily Railway Age Gazette* of June 11, 1915, page 1284, was the first of this



Young Valve Gear Applied to a Pacific Type Locomotive

type to be applied to a locomotive. It is the invention of O. W. Young who was for some years in charge of valve gear design for the American Locomotive Company, and it is controlled by the Pyle National Electric Headlight Company, Chicago.

The gear was designed primarily to give a better and more economical steam distribution. Of special interest is the performance of the engine at starting and at high speeds. A maximum cut-off of 88 per cent can be obtained with no deterimental effects to the other events of the stroke and it is possible to clear the cylinders of steam with practically no back pressure. This is shown by the indicator card, Fig. 1. This card was taken at starting, the speed being 5 m. p. h. The initial pressure is 184 lb. which is one pound less than the boiler pressure. The mean effective pressure is 173 lb., which gives an indicated tractive effort of 35,200 lb. This is 5,600 lb., or almost 19 per cent greater than the rated tractive effort of the engine. The back pressure lines of this card also show how easily the cylinder was cleared of the steam on the return stroke. This is the result of the extra long travel given the valve by the valve gear and the exceptionally open construction of the valve itself. A card taken at a speed of 40 m. p. h. with the Young gear is shown in Fig. 2, and Fig. 3 shows a card taken at the same speed with the Walschaert gear. The characteristics of these two cards are as follows:

	Fig. 2	Fig. 3
Type of gear	Young	Walschaert
Speed	40 m.p.h.	40 m.p.h.
Boiler pressure	185 lb.	185 lb.
Initial pressure (cylinder)	141 lb.	141 lb.
Mean effective pressure	76 lb.	45 lb.
Driving wheel diameter	72 in.	71 in.
Tractive power	15,440 lb.	9,270 lb.
Horsepower	1,645	988
Water per i. hp. hr.	24.55 lb.	27.20 lb.

This comparison shows the advantage the Young gear has over the Walschaert gear, the conditions being the same in both cases. Still more interesting, however, is the performance of the Young valve and valve gear at high speeds.

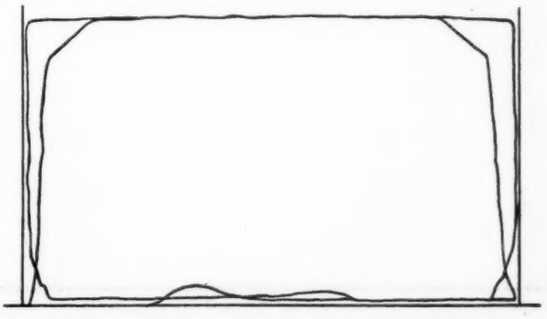


Fig. 1—Starting Indicator Card Taken with Young Valve Gear—Speed 5 Miles per Hour

An indicator card taken at a speed of 77 m. p. h. is shown in Fig. 4. The back pressure and compression lines are especially noteworthy. The back pressure is only 2.5 lb. and is remarkably constant throughout the return stroke when the speed at which the engine is running is considered. The compression curve shows that at even this high speed the cylinders are so well freed of steam that the compression could easily be begun at a point earlier in the stroke.

A study of these cards indicates that with this valve and gear a smarter engine is obtained at starting, more power is available and greater speeds are obtainable than with similar engines equipped with the Walschaert gear. In the report of the tests, shown below, it was stated that there scarcely seems to be any limit to the speed that this engine could make with the reverse lever in the twenty-first notch (almost at center) and the throttle only open a crack.

The tests were made on Pacific type locomotives of the same size and class, using superheated steam and having 23-in. by 28-in. cylinders with 185 lb. boiler pressure. Engine 293 was equipped with the Walschaert valve gear and engine 298 with the Young valves and valve gear. Both locomotives had made substantially the same mileage since

general shopping and were in practically the same condition. Engine 293 had drivers 71 in. in diameter, which gave it a rated tractive effort of 30,000 lb., while the drivers on engine 298 were 72 in. in diameter, giving it a rated tractive effort of 29,600 lb. One round trip was made with each engine in freight service and three in passenger service between Battle Creek, Mich., and Chicago. While the locomotives are generally used in passenger service they were tested on freight runs for the purpose of seeing how the Young gear would perform in that service. The average results of the tests are shown in the table. These results show a slight increase in evaporation in favor of engine 298 indicating that it had slightly better steaming qualities but the percentage decrease in the coal consumed per car-mile in passenger service and per ton-mile in freight service is far greater than that in the evaporation. In this connection it must be noted, however, that the tests are not strictly comparable because of the difference in temperature on the days the tests were made and also, in the case of the freight tests, because of the great difference in the time of detentions.

AVERAGE TEST RESULTS PER SINGLE TRIP WITH YOUNG AND WALSCHAERT VALVE GEARS

Item.	Freight Service		Passenger Service		Engine 298 Compared with 293—Per cent	
	7 hr. 1 min. Young	7 hr. 38 min. Walschaert	4 hr. 27 min. Young	4 hr. 26 min. Walschaert	Freight Service	Passenger Service
Type of valve gear					.....	.....
Number of engine	298	293	298	293	.....	.....
Number of round trips	1	1	3	3	.....	.....
Number of cars	45	41	8.66	9	+ 9.8	— 3.7
Gross weight of train, tons	1,612	1,485	.....	.....	+ 8.5	.....
Train miles	169	169	176	176	.....	.....
Car-miles	7,605	6,844	1,526	1,584	+11.1	— 3.6
Ton-miles	272,512	250,965	.....	.....	+ 8.5	.....
Coal consumed, tons	11.92	13.31	8.82	10.40	—10.4	—15.2
Coal per car-mile, lb.	3.20	3.9	11.58	13.35	—18.	—13.2
Coal per ton-mile, lb.	8.65	10.56	.....	.....	—18.1	.....
Water evaporated, lb.	173,044	187,250	107,602	118,860	— 7.5	— 9.4
Water evaporated per lb. of coal, lb.	7.25	7.08	6.13	5.73	+ 2.4	+ 6.9
Boiler pressure, lb. per sq. in.	180	178	180	177	+ 1.1	+ 1.6
Speed, m.p.h.	24.14	22.33	39.71	39.65	+ 8.1	+ 0.15
Actual running time	7 hr. 1 min.	7 hr. 38 min.	4 hr. 27 min.	4 hr. 26 min.	— 8.	.....
Detentions	1 hr. 36 min.	3 hr. 57 min.	23 min.	27 min.	—59.5	—16.6
Number of stops	11	18	12	13	—38.9	— 7.6
Temperature, deg. F.	40	17	41	26	.....	.....

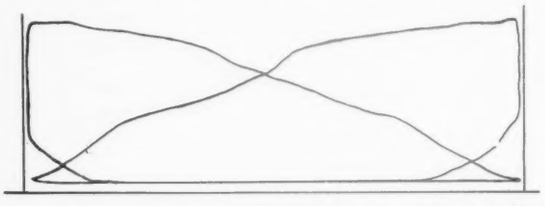


Fig. 2—Young Valve Gear Indicator Card at a Speed of 40 Miles per Hour

The general observations made during the test showed that engine 298 had a marked advantage over engine 293 in starting trains and, as above noted, in making speed. Engine 293 was stalled on a grade about one mile west of Battle Creek with a train of 1,550 tons while engine 298 with poorer rail conditions made the same grade with practically the same tonnage at a speed of 13 to 15 m. p. h. In the handling of the engine during the tests it was found that the Young gear was operated with ease at high speeds and that there was no vibration in the valve stem at any time, indicating that the gear is under no severe strains. This was to be expected as the gear is some 1,100 lb. lighter than the Walschaert gear, and the Young valve is decidedly lighter than the valve ordinarily used. In this particular instance the reciprocating weight of the valve and gear has been reduced 40 per cent.

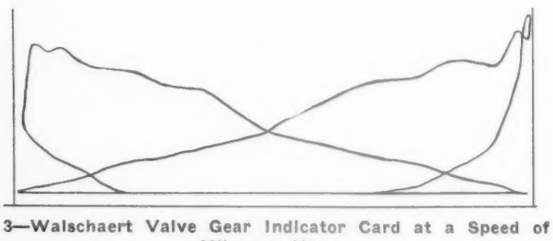


Fig. 3—Walschaert Valve Gear Indicator Card at a Speed of 40 Miles per Hour

While this gear has not been in service long enough to determine its actual maintenance cost it is expected to prove more economical to maintain than the Walschaert gear and the ordinary piston valve. The Young valve is lighter due to the packings being carried in the valve bushing instead of the valve and this feature also permits the valve to be made much simpler in construction. The gear itself is also of simple construction. It derives its motion direct from the crosshead, there being no revolving parts. It is so designed that it can be made standard on a wide range of locomotives of various designs, and the valve can be used with any other type of valve gear. With the application of this valve and gear to locomotives it is possible to obtain the same results with a smaller diameter of valve than when the Walschaert gear is used because of the increased port openings made possible by the increase in the length of travel of the valve.

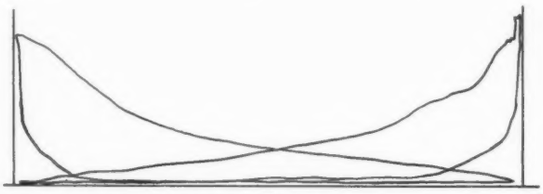


Fig. 4—Young Valve Gear Indicator Card at a Speed of 77 Miles per Hour

BUCKLING OF FIRE TUBES.—The buckling may result from relaxation of the stresses that are introduced by bending the tube to straighten it or for the purpose of getting it in the boiler, or may be due to one side of the tube becoming heated more than the other from carrying a low water level or from a deposit of scale on the tube.—*Power.*

REDUCING BLOWDOWN OF SAFETY VALVES. — Most pop safety valves are provided with an adjustable sleeve, or ring, that causes the escaping steam to react against the valve in such a manner as to assist the pressure of the boiler in holding the valve off its seat. By moving the ring farther away from the valve, there will be less reaction of the escaping steam and the amount of blowdown will be reduced.—*Power.*

EXPRESS LOCOMOTIVES IN FRANCE

Six-Coupled Engines of the Four-Cylinder Compound Type Prevail; Schmidt Superheaters Used

BY EDOUARD SAUVAGE

With the exception of some locomotives of the Atlantic type, which are not likely to be reproduced, all the engines built in France for express passenger service since 1904 are six-coupled, either ten-wheelers (4-6-0) or Pacifics (4-6-2). Superheated steam is largely used, especially in the latest construction. With a few exceptions, the Schmidt standard superheater has been adopted.

Except on one road, all engines for express service have four cylinders, with a large proportion of compounds; in a few cases, single expansion, in four equal cylinders, is used, but the compound system appears altogether to be preferred. The one exception is the recent building, by the Midi Railway, of simple engines with only two cylinders, using superheated steam, for express service.

When the superheaters have been added to the four-cylinder compounds, the diameter of the high-pressure cylinders has been increased, the low-pressure cylinders being left unaltered. Piston valves are generally used on all cylinders, even on non-superheaters, but in a few cases, for instance, on Paris-Orléans engines, flat valves have been preserved on the low-pressure cylinders of superheater locomotives.

The usual practice is to have four separate valve motions, of the Walschaert type, for the different cylinders of the compounds; the reversing gear can operate at will the high-pressure and the low-pressure motions together, or only one of them. The starting device, when admitting steam directly to the low-pressure cylinders, opens a direct exhaust to the high-pressure. An exception is to be found on the Paris-Lyons-Méditerranean engines: the low-pressure valve motion gives always the same admission backwards and forwards; it is operated by the same screw as the high-pressure motion, but is only transferred from one position to the other when reversing. The high-pressure valve motion being designed to give a very prolonged admission, the starting device comprises only a cock admitting live steam into the low-pressure cylinders, without special exhaust for the high-pressure.

As regards details it may be mentioned that, in some engines, the damper-box and doors, that enclose in the smoke-box the collectors and ends of superheating pipes, have been taken off. No inconvenience seems to result from this suppression. Trouble would arise from a prolonged use of the blower, which may be avoided. If further experience proves that this mechanism can be dispensed with, including the steam cylinder for the automatic working of the damper, the saving in first cost and expenses for repairs will not be negligible, as well as the reduction in weight of about 660 lb.

The driver's station, that used to be on the right side of the engine, has been transferred to the left. Bogie wheels are, as a rule, braked.

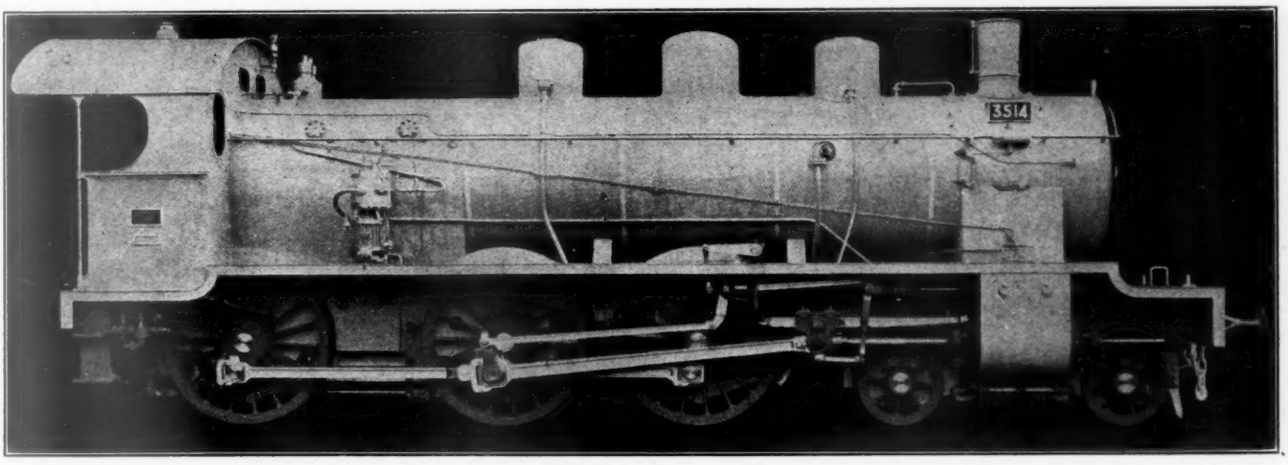
Tables I and II give the leading dimensions of the latest 4-6-0 and 4-6-2 type locomotives for the different railway systems. Following are some details on the practice of each railway system:

TABLE I.

Principal Dimensions of Recent 4-6-0 Type Locomotives, with Superheaters

	East. 4-cyl. compounds	P. L. M. 4-cyl. compounds	State 4-cyl. simple	Nord. 4-cyl. compounds	Midi. 2-cyl. simple
Grate area, sq. ft....	34.02	32.07	29.92	29.71	29.92
‡Heating surface, sq. ft.	1,709.90	1,611.87	1,464.65	1,766.77	1,730.27
Superheat'g surf., sq. ft.	400.97*	362.0	463.18	430.89	530.89
Tubes, number and outside dimensions, in.....	21—5.23 28—1.93 75—2.76†	21—4.99 19—1.97 64—2.76†	22—5.23 139—1.97	22—5.23 20—1.97 60—2.76†	24—5.23 143—1.97 .....
Length between tube sheets, ft. in.....	14—5	13—1	14—1	14—1	.....
Mean diam. of barrel, ft. in.....	5—1	4—11	5—3	4—9	5—0
Height of center above rail, ft. in.....	8—10	8—6	9—2	8—7	.....
Working pressure, lb. per sq. in.....	227.6	227.6	170.7	227.6	170.7
Diameter of driving wheels, in.....	82	79	80	69	69
Diam. of cyls., in.....	15.35 and 23.93	14.57 and 21.27	16.93	14.96 and 21.66	23.23 .....
Stroke of piston, in..	27	24	25	25	25
Weight in working order, long tons.....	76.9	72.0	70.4	68.6	75.1
Weight on drivers, long tons	52.3	50.2	48.1	49.0	53.1

*488.4 sq. ft. with Mestre's superheater.
†Serve ribbed tubes.
‡In France the heating and superheating surfaces are generally computed on the fire side, including the whole surface of the ribs of serve tubes. An exception is made on the East Railway.



Midi Railway Two-Cylinder Simple Locomotive, Equipped with Superheater.

EAST RAILWAY

Other systems of superheaters besides the Schmidt have been experimented upon. First, for fear of overheating the

*From a paper presented before the Institution of Mechanical Engineers.

high-pressure cylinders, superheating in two stages was resorted to, high-pressure steam being moderately superheated, while receiver steam passed a second superheater. This plan has been abandoned. A helical superheater, on the principle of the Field tube, with ribs, was fitted to some engines, and was abandoned, too, on account of its insufficient surface and of the difficulty of cleaning its outside ribs. Another system is the Mestre squirrel-cage superheater, which is working on some engines and gives ample surface. In some engines the receiver comprises a number of large pipes in the smoke-box with a heating surface of 83.3 sq. ft., the object being to dry or even to superheat the low-pressure steam.

This contrivance does not seem to have any well-marked effect.

The ends of the superheating tubes, which are steel castings in Schmidt's system, come close to the firebox, the distance being reduced to 21.7 in. It has been found that these castings rapidly become covered with a slag deposit that protects them from a too intense heat.

With the exception of the points mentioned, the several lots of these engines show but slight differences. The principal dimensions are given in Table I. The heating surface is computed on the side in contact with combustion gases; in the case of Serve tubes, it is reckoned as the mean between the actual surface ribs included and the surface of a plain tube of the same inside diameter. The surface of the superheaters is the mean between their inside and outside surfaces.

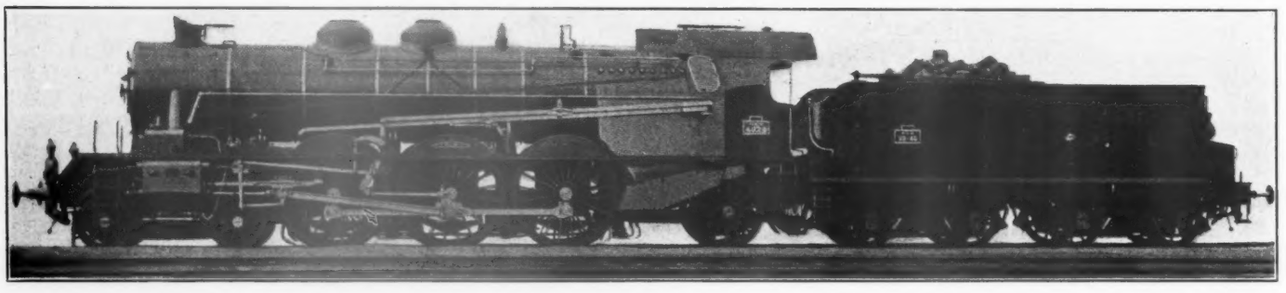
These engines have six-wheeled tenders, holding 4,850 Imperial gal. of water and 8 long tons of coal, weighing empty 20 long tons. Mr. Lancrenon, chief engineer of the East Railway, declares these six-coupled engines give entire satisfaction. Although utilized mainly for fast trains, they

Table II

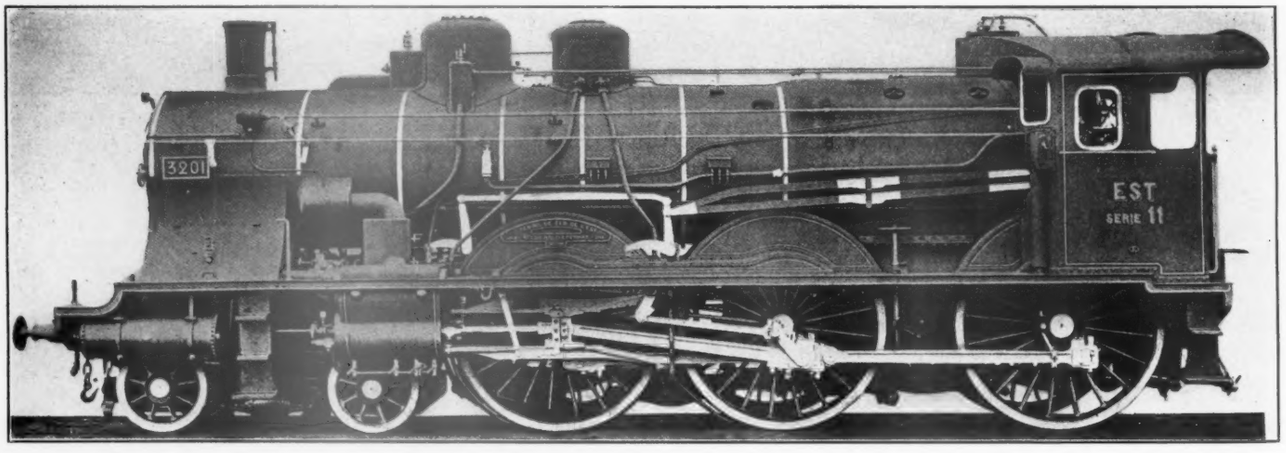
Principal Dimensions of Recent Pacific Type Locomotives

	P. L. M.		State	Nord.	Paris-Orleans		Midi	
	4-cyl. compounds	4-cyl. simple	4-cyl. compounds	4-cyl. compounds	4-cyl. compounds without superheater	4-cyl. compounds with superheater	4-cyl. compounds	2-cyl. simple
Grate area, sq. ft.	45.75		45.96	34.67	45.96		43.27	43.06
Heating surface, sq. ft.	2,175.3	2,360.6	2,270.84	2,292.5	2,768.99	2,271.95	2,328.12	2,167.9
Superheating surface, sq. ft.	693.98	760.28	683.5	484.4	.....	673.9	655.3	769.7
Tubes, number and outside diameter, in.	28—5.23		24—5.23	24—5.23	.....	24—5.23	24—5.23	28—5.23
	143—2.17		151—2.17	90—2.76*	257—2.17	151—2.17	145—2.24	122—2.24
Length between tube sheets, ft. in.	18—0.53	19—8	19—4.3	14—9	19—4.3	.....	.....	.....
Mean diameter of barrel, ft. in.	5—5.39	5—6	5—6.13	5—4.61	5—6.13		5—6.13	5—6.77
Height of center above rail, ft. in.	9—9.7		9.42	9—3	9—4.2		.....	.....
Working pressure, lb. per sq. in.	227.57	199	227.57	227.57	227.57		227.57	184.90
Diameter of driving wheels, in.	79		76.4	80	76.4		76.4	76.4
Diameter of cylinders, in.	17.33	19	16.54	16.14	15.35	16.54	15.75	24.80
	25.59	..	and 25.20	and 25.62	and 25.20	and 25.20	and 24.41	.....
Stroke of pistons, in.	25.59		25.59	25.98	25.59		25.59	25.59
Weight in working order, long tons	89.8	91.6	93.6	84.2	88.9	90.7	89.9	87.9
Weight on drivers, long tons	54.9		53.1	48.4	51.7	52.1	53.1	53.1

*Serve tubes.



Paris-Lyons-Mediterranean Pacific Type Locomotive



Ten-Wheel Locomotive Used on the Est Railway

can negotiate all passenger, and even occasionally heavy freight trains. They attain easily the limit speed of 74.6 miles an hour and run smoothly without injuring the track; the expenses for keeping up, as well as coal and water consumption, are moderate.

As regards boiler pressure, the practice of the East Railway is to reduce the maximum allowed by one unit, so as to be certain that this maximum is never exceeded. On boilers marked 227.6 lb. per sq. in. the safety valves blow off at 213.35 lb. per sq. in.

PARIS-LYONS-MEDITERRANEAN

Comparative trials of No. 6102 (simple, 4-6-2 type, superheater) and No. 6204 (compound, 4-6-2 type, superheater) were made on this road between Laroche and Dijon, the line rising from Laroche to Blaisy (82.0 miles) with long continuous grades of about 1 in 200.

With trains weighing as much as 487 tons, locomotive 6102 (simple) indicated 2,051 hp.,* the utilized power on the draw bar being 1,364 hp. The water consumed per hour and per indicated horse power varied, in the different experiments, from 19.1 lb. to 21.5 lb., the gross coal consumption, including lighting up of fires, from 3.42 lb. to 40 lb., and the net coal consumption (deduction made for lighting up) from 2.98 lb. to 3.5 lb. In some cases as much as 1,543 lb. of coal were shovelled in per hour and for each 10.764 sq. ft. of grate.

Compound locomotive 6204 hauled trains of 646 tons at an average speed of 49.7 miles to 55.9 miles an hour from Laroche to Blaisy; 2,425 hp. was indicated and 1,604 hp. registered by the dynamometer on the drawbar. The water consumed per hour and indicated horse power varied from 13.51 lb. to 15.03 lb., the gross coal consumption from 2.27 lb. to 2.69 lb. The rate of combustion never exceeded 1,183.9 lb. per hour and for each 10.764 sq. ft. of grate.

*1 French hp. equals 542.5 ft. lb. per second.

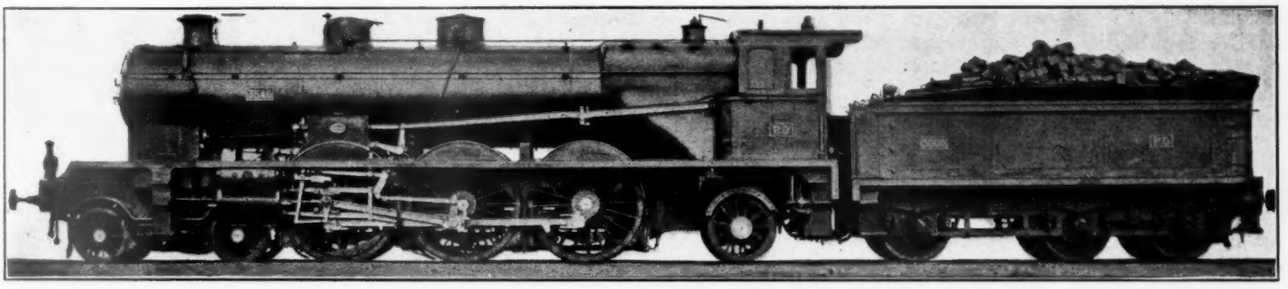
STATE RAILWAYS

No precise experimental data, referring to the types of engines mentioned, are available. As regards the comparison of simple four-cylinder engines versus compounds, all with superheaters, the impression of some officials of the State railways seems to be in favor of the compound principle.

NORD

The locomotives used for fast trains on the Nord since 1904 are all four-cylinder compounds. They consist of 35 of the Atlantic type; 150 of the 4-6-0 type; 2 Baltic* type engines (4-6-4), and 20 Pacific type.

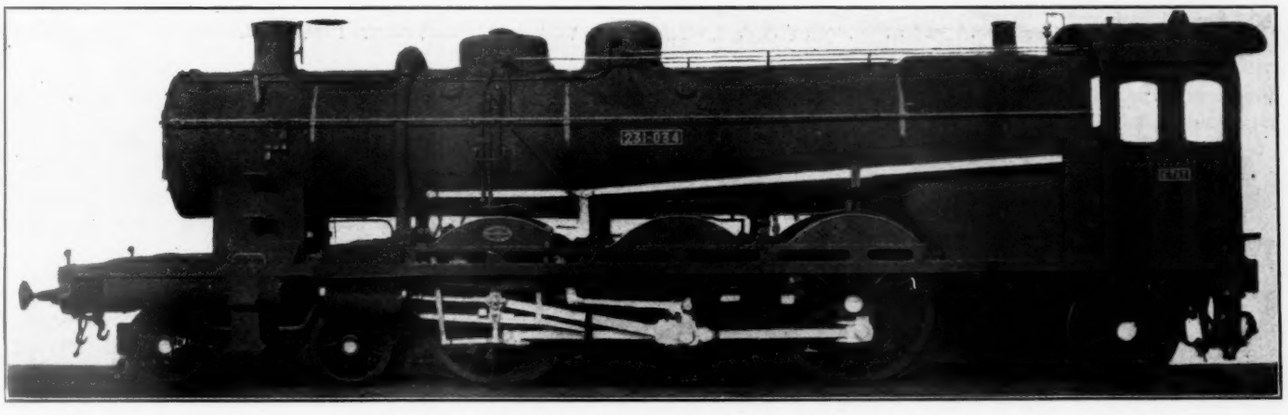
The six-wheel tenders of some of these engines have been designed with a view of reducing, as far as possible, the fireman's work. The coal tank is entirely in front, with a bottom sloping at an angle of 45 deg. On both sides, auxiliary tanks are provided for briquettes, which are also close at hand.



Paris-Orleans Pacific Type Locomotive

Owing to the moderate diameter of their wheels, these engines may be used for every kind of service; they negotiate heavy freight as well as fast passenger trains. This has proved a great convenience on the Nord, where in the fall of the year the freight traffic is heavy, while in summer and on holidays a large number of supplementary expresses, all heavy, have to be run.

It was not thought advisable to build more locomotives of the Baltic type before a longer experience; for this reason 20 Pacific type engines were placed in servic- at the end of 1912 with the same diameter of wheels that the Atlantics had, but with a greater power and more adhesive weight. The principal dimensions of these Pacifics are given in Table II.



Pacific Type Locomotive Used on the French State Railways

One peculiarity of these engines is the use of by-passes on their high pressure cylinders instead of air relief valves. After the results of experiments on the first of these engines,

*For description see *American Engineer*, April, 1913, page 190.

the section of the steam pipes, the length of ports of the high pressure cylinders, and the travel of the valves was increased, with a notable gain of power. The indicated power in regular working attains 1,900 hp. to 2,000 hp.; 2,120 hp. was obtained on one occasion. With a train of 422 tons the speed has been increased from 21.7 to 57.2 miles an hour on the 1 in 200 grade from St. Denis to Goussainville. On the 1 in 125 grade from Marquise to Caffiers, 4.97 miles long, the speed fell from 64.6 miles to only 46.6 miles an hour, with the same train.

Superheating has been adopted for all recent Nord engines, and will be continued in future engines; with steam temperatures of 300 deg. to 340 deg. C., no undue expenses for repairs have been experienced. The Nord engineers are of opinion that superheating and compounding must be combined.

The two Baltic type engines are mere experiments. As regards power they are far in advance of the Pacifics, but far less economical.

PARIS-ORLEANS

The shape of the firebox of the Paris-Orleans Pacific type engine is peculiar; it extends over the back trailing wheels, but also extends between the last pair of drivers, the object being to avoid a shallow box. Reports of the working of this style of firebox are quite satisfactory. Owing to the great length of the tubes, 19 ft. 4 in. between tube sheets, plain ones without ribs have been adopted, with an outside diameter of 2.17 in. The necessity of increasing the diameter of very long tubes is obvious; but the reason why they are not of the Serve system is not evident. It may be that a sufficient heating surface being obtained with plain ones, it is better to avoid the increase in cost and weight of the ribbed tubes.

Indicator diagrams on the superheater engine made apparent a too high compression in the high pressure cylinders. The clearance being enlarged, a smoother running was obtained without any increase of steam consumption. Experiments with fast and heavy trains showed an indicated power up to 2,180 hp. and 1,266 hp. on the drawbar behind the tender.

An interesting comparison was made in actual running of twenty Pacifics without and of fifteen with superheaters, taking in turns the same trains. The mean coal consumption per 100 ton-kilometre was, in winter, including steam heating of the trains, 8.64 lb. for engines without superheaters, and 7.74 lb. for engines with superheaters. In summer the figures were, respectively, 7.78 lb. and 6.99 lb. These figures show an economy averaging 10 per cent in favor of the superheat.

MIDI

During the last decade the Midi Railway has added to its motive power a number of Atlantic ten-wheel and Pacific type locomotives. The leading dimensions of the latter types are given in the tables.

All-Steel Train in India.—The Great Indian Peninsular Railway has recently put in service the first complete all-steel train in India. The train was built in England, shipped to India in parts and put together in the shops at Bombay.

Properties of Autogenous Welds.—The strength of the joint produced by autogenous welding has been a fruitful source of discussion in the application of the process, and many contentions have been advanced as to the necessity of welds of highest tensile strength. It was early found that welds having a breaking strength equivalent to that of the metal itself could be produced, but the sacrifice of elongation and reduction of area materially lessened the apparent value of such welds.—*Valve World.*

GREASE LUBRICATION OF LOCOMOTIVE DRIVING BOXES

BY GEORGE J. BURNS
President, Burns System, Inc., Chicago

To the extent of the writer's observation there is but one railroad applying grease lubrication to its locomotive driving boxes in accordance with scientific principles, which are so simple, obvious and well recognized that, were they not disregarded, their mere enumerations would be inexcusably elementary.

Lubrication is the intervention bewteen sliding surfaces of a substance the properties of which are such that: a film of it adheres to each surface; the molecules, beyond the adhering zone, roll over and slide upon each other with a minimum amount of frictional resistance. The principal rule of lubrication is to introduce the lubricant at the point of least resistance and to prevent its escape at the point of greatest pressure. A set of gages applied to the side of a driving box, the journal of which runs in a bath of oil, indicates that the pressure is zero at the point where the oil enters, and that it gradually increases up to a point just over the crown in the direction of the movement of the journal, from which point it rapidly falls off. It is to be observed, as confirming this, that a crown brass wears upward and slightly forward.

A properly designed driving box with a grease cellar is a most effective example of force lubrication. As the journal revolves, the molecules of the lubricant between it and the crown brass slide and roll over each other, each being pushed forward by the combined pressure of those behind it. The forward movement might be compared to that of anti-friction ball bearings. The efficiency of lubrication is dependent upon the maintenance and forward movement of an intervening film of the lubricant, the forward pressure depending upon the speed of the journal. The rate at which the forward movement of the lubricant takes place is dependent upon the pressure and the fluidity of the lubricant. As the lubricant not only reduces the coefficient of friction but absorbs and carries away heat and flushes the bearing, its forward movement through the bearing is essential.

When driving boxes were lubricated with oil, introduced through a hole at the top, the movement of the journal tended to keep the oil from the back quarter of the bearing. It was, therefore, necessary to cut radiating grooves in the face of the crown brass in order that the lubricant might flow by gravity to the portion of the journal that the oil could not otherwise reach. Lubrication by a grease cellar being the reverse of oil lubrication, grooves are not only unnecessary but are a positive obstruction to lubrication. They are not a factor in drawing in the lubricant and they provide a means for its escape at the point of greatest pressure where it is most needed. They reduce the bearing area of the crown brass and if left in the scale they tend to cut and roughen the journal.

Like many other railroad mechanics, the writer accepted the opinion of the manufacturer of the grease cellar until through constant observance he had come to accept grooves in a crown brass as an essential element of driving box design. He was, therefore, not a little surprised to note their omission on one road, and that their omission was attended by a decrease in the number of hot boxes. Appreciating that every result has a cause, his attention was directed to a study of the principles of lubrication.

The greatest handicap to increased efficiency in railway shops is an obsession resulting from a long observance of "usual" practices.

Double-Eccentric Engine.—Engines known as double-eccentric engines are provided with one eccentric for operating the admission valves and another for operating the exhaust valves.—*Power.*

EXAMPLES OF RECENT LOCOMOTIVES OF THE SANTA FE AND CONSOLIDATION TYPES

ARRANGED IN ORDER OF TOTAL WEIGHT

Type	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-8-0	2-8-0	2-8-0	2-8-0	2-8-0	2-8-0	2-8-0	2-8-0	2-8-0
Name of road	Erie	B. & O.	Erie	C.B.&Q.	C. & S.	N.Y.O.&W	C.I.&L.	A.T.&S.F.	P.S.&N.	D.&H.	W.&L.E.	Penn.Lines	W.M.	K.&M.	Interstate	M.&O.	B.&A.	Tol.Term.
Road number or class	....	6000	4102	6109	900	353	....	....	....	1200	2401	9710	781	552	8	547	176	34
Builder	Baldwin	Baldwin	Amer.	Baldwin	Baldwin	Amer.	Amer.	....	Amer.	Amer.	Amer.	Baldwin	Amer.	Amer.	Baldwin	Amer.	Amer.	Amer.
When built	1915	1914	1915	1914	1915	1915	1915	1915	1915	1915	1913	1915	1914	1914	1915	1914	1914	1915
Tractive effort, lb	83,000	84,500	83,000	71,500	71,500	71,200	66,700	63,600	59,800	61,400	55,900	53,000	62,500	50,400	50,000	44,370	42,200	39,500
Weight, total, lb	417,200	406,000	401,000	370,000	367,850	352,500	341,000	296,700	280,450	293,000	266,500	249,500	244,500	239,500	222,600	220,000	208,000	198,000
Weight on drivers, lb	337,400	336,800	335,500	293,000	295,950	293,000	275,500	248,900	233,350	267,500	236,000	226,900	217,500	209,500	192,200	191,500	181,000	176,000
Weight on leading truck, lb	25,300	22,700	34,000	27,900	25,200	31,000	27,000	22,300	24,800	25,500	30,500	22,600	27,000	30,000	30,400	28,500	27,000	22,000
Weight on trailing truck, lb	54,500	46,500	31,500	49,100	46,700	28,500	38,500	25,500	22,300	.....	.....	.....	.....	.....	.....	.....	.....	.....
Weight of tender, loaded, lb	186,900	178,000	184,500	185,000	194,150	168,700	177,000	185,400	149,930	193,200	177,300	181,500	179,500	154,000	137,400	151,000	145,300	134,100
Wheel base, driving, ft. & in	22—0	21—0	22—6	20—0	20—9	20—0	20—0	19—9	19—9	17—6	17—0	17—0½	16—8	17—3	17—0	16—6	16—9	14—3
Wheel base, total engine, ft. & in	41—3	40—3	40—3	40—1	40—1	36—9	38—5	35—10	35—11	26—7	27—0	25—9½	26—2	26—5	26—3	25—1	25—3	23—4
Wheel base, engine and tender, ft. & in	75—0	76—6	71—9½	74—9¼	74—9¼	66—10	73—8	66—4	67—4	65—5	62—3	62—5⅛	68—0	58—2¾	58—10	61—6⅞	58—10½	57—7¼
Diameter of drivers, in	63	58	63	60	60	57	57	57	57	63	57	62	51	57	61	63	56	51
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter, in	31	30	31	30	30	28	28	28	28	27	26	26	25	25	25	24	23	22
Cylinders, stroke, in	32	32	32	32	32	32	30	32	32	32	30	28	30	30	32	30	30	28
Valve gear, type	Baker	Wals.	Baker	Wals.	Wals.	Baker	Wals.	Wals.	Wals.	Baker	Wals.	Wals.	Baker	Wals.	Southern	Wals.	Baker	Wals.
Steam pressure, lb	200	200	200	175	175	190	190	170	160	195	185	205	200	180	180	190	175	175
Boiler, type	Straight	Straight	E. W. T.	Straight	Straight	E. W. T.	E. W. T.	E. W. T.	W. T.	Straight	E.W.T.	E.W.T.Bel	Straight	E. W. T.	Straight	Straight	E. W. T.	E. W. T.
Boiler, smallest outside diameter, in	96	90	90½	88⅛	88⅛	84½	83½	80¼	78¾	86	83 9/16	78½	83¾	80	80	76½	69 15/16	72½
Tubes, number and diameter in inches	259—2¼	269—2¼	317—2¼	264—2¼	264—2¼	337—2	225—2¼	251—2¼	391—2¼	326—2	293—2	265—2	239—2¼	266—2	248—2	220—2	204—2	222—2
Flues, number and diameter in inches	48—5¼	48—5½	60—5½	45—5½	45—5⅝	50—5⅜	45—5⅜	36—5½	.....	46—5⅜	43—5⅜	36—5⅜	36—5½	36—5⅜	36—5⅜	32—5⅜	30—5⅜	32—5⅜
Length of tubes and flues, ft. & in	24—0	23—0	17—0	22—7½	22—7½	17—0	23—0	21—0	20—0	15—0	15—6	15—1	15—3	15—6	15—3	15—0½	14—9	13—10
Heating surface, tubes and flues, sq. ft	5,505.5	5,215	4,617.5	4,966	4,966	4,173	4,485	4,174	4,586	3,509	3,293.4	2,841	2,919.3	2,926	2,737	2,395	2,185	2,215.7
Heating surface, firebox, sq. ft	357.6†	358†§	341.5†	383†	383†§	325†	276†	216†	210	305†	223.7	175	228.5†	227†	214†	173	298†	209†
Heating surface, total, sq. ft	5,863.1	5,573	4,959	5,349	5,349	4,498	4.761	4,390	4,796	3,814	3,517.1	3,016	3,147.8	3,153	2,951	2,568	2,383	2,424.7
Heating surface, superheater, sq. ft	1,389	1,329	1,274.2	1,232	1,232	1,007	1,235	910	.....	793	774	623	594.4	633	646	545.8	496	499
Heating surface, equivalent,* sq. ft	7,946.6	6,901	6,870	7,197	7,197	6,008.5	6,613	5,755	.....	5,003	4,291.1	3,950	4,039.4	3,786	3,920	3,113.8	2,879	3,172.7
Grate area, sq. ft	88	88	94.8	88	88	80	70	58	58	99.8	66.75	55	61.3	55	54	53	46.8	54.5
Firebox, length, in	132	132	160	132	132	150	120	108	108	126	114	110¼	111	108⅛	108	106½	108⅛	107⅛
Firebox, width, in	96	96	108¼	96	96	96¼	84¼	78	78	114	84¼	72	80¼	73¼	72	71¾	62¼	73¼
Kind of fuel	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal
Tender, fuel capacity, tons or gallons	20	16	19	15	20	15	13	12	14	14½	15	17	14	16	12	12	12	15
Tender, water capacity, gal	10,000	10,000	10,000	10,000	10,000	9,000	9,500	9,000	8,500	9,000	9,000	8,000	9,500	7,500	7,000	7,500	7,500	6,000
Weight on drivers ÷ tractive effort	4.0	3.9	4.0	4.1	4.1	4.1	4.1	3.9	3.9	4.3	4.2	4.3	3.5	4.1	3.8	4.3	4.2	4.4
Total weight ÷ tractive effort	5.0	4.8	4.8	5.2	5.1	4.9	5.1	4.6	4.7	4.7	4.7	4.7	3.9	4.7	4.5	4.9	4.9	5.0
Tractive effort × diam. drivers ÷ equivalent heating surface*	658.0	710.2	761.1	596.1	596.1	675.5	574.9	632.0	712.0	774.0	742.5	832.0	789.1	757.1	778.0	897.7	820.8	635.0
Equivalent heating surface* ÷ grate area	90.3	78.4	72.4	81.8	81.8	74.9	94.2	97.9	81.9	50.0	64.3	71.8	66.0	68.9	72.7	58.6	61.5	58.2
Firebox heating surface ÷ equivalent heating surface*, per cent	4.5	5.2	5.0	5.3	5.3	5.4	4.2	3.8	4.4	6.1	5.2	4.4	5.6	6.0	5.5	5.5	10.3	6.6
Weight on drivers ÷ equiv. heat. surface*	42.7	48.8	48.8	40.7	41.1	48.7	41.6	43.5	48.7	53.5	55.0	57.5	53.9	55.4	48.8	61.5	62.9	55.5
Total weight ÷ equiv. heating surface*	52.9	58.9	58.3	51.4	51.2	58.6	51.6	51.8	59.4	58.6	62.1	63.2	60.5	63.2	56.8	70.6	72.3	62.5
Volume both cylinders	27.9	26.2	27.9	26.2	26.2	22.8	21.4	22.8	22.8	21.2	18.5	17.2	17.0	17.0	18.3	15.7	14.4	12.3
Equiv. heating surface* ÷ vol. cylinders	284.3	264.0	245.8	274.0	274.0	263.5	309.3	251.3	216.3	236.0	232.0	229.5	238.0	223.0	214.0	198.0	200.0	258.0
Grate area ÷ vol. cylinders	3.1	3.3	3.3	3.3	3.3	3.5	3.3	2.6	2.5	4.7	3.6	3.2	3.6	3.2	3.0	3.3	3.2	4.4
Reference to photographs, drawings or description			R.A.G.April 1916-p887	Loco.Dic. 1916-p169		R.A.G.April 1916-p887	Loco.Dic. 1916-p169				R.A.G.M.E.‡ 1913-p641			R.A.G.July 1914-p101					

* Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface. ‡ *Railway Age Gazette, Mechanical Edition.*

§ Includes combustion chamber heating surface. † Includes arch tube heating surface.

EXAMPLES OF RECENT LOCOMOTIVES OF THE MALLET AND MIKADO TYPES

ARRANGED IN ORDER OF TOTAL WEIGHT

Type	2-8-8-8-2	2-8-8-2	2-6-6-2	2-6-6-0	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2
Name of road	Erie	N.C.&St.L.	B.R.&P.	D.&S.L.	E.P.&S.W.	R.I.	P.R.R.	C.B.&Q.	M.K.&T.	L.&N.	Montour	A.T.&S.F	Seaboard	S. P.	Me Cent.	N.C.&St.L.	M.&St.L.	C.P.R.
Road number or class	5014	902	701	210	367	2572	1752	5305	802	2400	20	3112	303	3270	601	608	600	5088
Builder	Baldwin	Baldwin	Amer.	Amer.	Amer.	Baldwin	R. R. Co.	Baldwin	Amer.	R. R. Co.	Amer.	Baldwin	Amer.	Baldwin	Amer.	Baldwin	Amer.	Mont.Loc.
When built	1914	1915	1914	1913	1914	1913	1914	1915	1915	1914	1915	1913	1914	1914	1914	1915	1915	1913
Tractive effort, lb	160,000	98,500	80,000	76,400	59,900	57,000	57,850	60,000	60,600	57,000	64,500	50,700	50,200	51,000	51,200	49,500	46,000	42,000
Weight, total, lb	853,000	469,400	429,000	359,000	321,000	319,300	319,300	315,400	314,000	302,000	296,500	284,100	282,000	280,960	275,000	264,300	260,000	258,000
Weight on drivers, lb	761,600	430,300	355,500	331,500	242,000	238,200	238,850	239,900	233,500	236,000	249,500	218,900	207,500	214,020	213,500	205,000	187,000	198,000
Weight on leading truck, lb	32,000	20,100	24,500	27,500	26,000	29,000	29,700	28,000	28,500	25,000	24,000	24,500	26,500	24,240	22,500	20,700	27,500	25,000
Weight on trailing truck, lb	59,400	19,000	49,000	.....	53,000	52,100	50,750	47,500	52,000	41,000	23,000	40,700	48,000	42,700	39,000	38,600	45,500	35,000
Weight of tender, loaded, lb	.....	165,600	169,300	160,500	174,000	160,700	158,000	182,100	165,100	169,500	164,200	170,900	183,000	170,040	156,000	155,700	156,000	170,000
Wheel base, driving, ft. & in	71—6	40—4	10—6	10—0	16—6	17—0	17—0½	16—9	16—6	16—0	16—6	16—0	16—6	16—6	16—6	15—9	15—9	16—6
Wheel base, total engine, ft. & in	90—0	55—8	49—10	39—1	35—3	35—2	36—4½	35—9	34—10	35—4	34—1	34—9	35—2	34—9	34—9	34—4	33—7	35—5
Wheel base, engine and tender, ft. & in	90—0	85—7¾	81—5¾	72—9	68—4¾	67—0½	72—3	67—6¼	69—10¾	68—7½	65—6	66—0¼	72—6½	69—9⅛	69—1½	69—7	63—6¾	66—5
Diameter of drivers, in	63	56	57	55	63	63	62	64	61	60	57	57	63	63	63	58	59	63
Cylinders, number	6	4	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter, in	36	27 & 41	23½ & 37	21 & 33½	29	28	27	28	28	27	27	25	27	26	26½	25	24	23½
Cylinders, stroke, in	32	30	32	32	30	30	30	32	30	30	32	32	30	28	30	30	30	32
Valve gear, type	Baker	Wals.	Wals.	Wals.	Baker	Baker	Wals.	Wals.	Baker	Wals.	Baker	Wals.	Wals.	Wals.	Wals.	Wals.	Baker	Wals.
Steam pressure, lb	210	210	200	225	176	180	205	180	185	185§	185	170	170	200	180	180	185	180
Boiler, type	Conical	Conical	Straight	Conical	Straight	Straight	Belpaire	Straight	Straight	E. W. T.	Straight	W. T.	E. W. T.	Straight	.....	W. T.	E. W. T.	E. W. T.
Boiler, smallest outside diameter, in	94	88	89¾	84	85¾	86	78½	88½	86⅜	80	88	78¾	73 15/16	82	74	76	70	72
Tubes, number and diameter in inches	326—2¼	253—2¼	235—2¼	235—2¼	234—2¼	234—2¼	237—2¼	264—2¼	238—2¼	219—2¼	312—2	240—2¼	230—2	275—2	234—2	241—2	170—2¼	210—2¼
Flues, number and diameter in inches	53—5½	43—5½	.....	36—5½	43—5½	36—5½	40—5½	45—5½	42—5½	40—5½	45—5⅜	36—5½	32—5⅜	36—5⅜	32—5⅜	34—5⅜	32—5½	30—5¼
Length of tubes and flues, ft. & in	24—0	24	24—0	20—6	20—0	21—0	19—0	18—7¼	20—6	20—0	16—0	20—0	20—0	20—6	17—0	20—6	19—0	.....
Heating surface, tubes and flues, sq. ft	6,418	5,044	4,547	3,882	3,975	4,017	3,746.8	4,080	4,094	3,680	3,606	3,849	3,290	3,973	2,832.2	3,553	2,764	3,410
Heating surface, firebox, sq. ft	468†§	398†§	388	229	254.9	259†	288.6	385†§	247†	263.29†	286†	262	247†	242	273.3†	351†	231†	188
Heating surface, total, sq. ft	6,886	5,433	4,935	4,111	4,229.7	4,276	4,035.4	4,465	4,341	4,865	3,892	4,111	3,537	4,215	3,105.5	3,804	2,995	3,598
Heating surface, superheater, sq. ft	1,584	1,262	1,025.5	879	1,030.1	900	1,153.9	1,005	1,025	922	836	880	759	890	636.4	840	706	760
Heating surface, equivalent,* sq. ft	9,262	7,326	5,960.5	4,990	5,259.8	5,626	5,766.3	5,972	5,878	5,326	5,146	5,431	4,675.5	5,550	4,060.1	5,064	4,054	4,738
Grate area, sq. ft	90	85.5	72.2	72.2	70.3	63	70	78	62.7	58	66.7	58.5	63.2	70.4	56.5	66.6	55	50
Firebox, length, in	162	126	108⅛	108 1/16	120⅛	108	126	117	107	112¾	142⅛	108	108	120⅝	108⅛	114⅜	108⅛	103¼
Firebox, width, in	108	97¾	96¼	96¼	84¼	84	80	96	84	72¼	84¼	78	84¼	84	75¼	84¼	73¼	69⅞
Kind of fuel	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal
Tender, fuel capacity, tons or gallons	16	14	14	12	15	16	12½	20	12½	18	12	12	17	2,940	14	14	11¾	16
Tender, water capacity, gal	10,000	8,500	9,000	9,000	9,000	9,000	7,000	9,200	8,000	8,500	9,000	8,500	9,000	9,000	8,000	8,500	8,500	8,402
Weight on drivers ÷ tractive effort	4.7	4.3	4.4	4.3	...	4.1	4.1	4.0	3.9	4.1	3.9	4.3	4.1	4.2	4.1	4.1	4.1	4.7
Total weight ÷ tractive effort	5.3	4.8	5.3	4.7	5.4	5.6	5.5	5.3	5.2	5.3	4.6	5.6	5.6	5.5	5.3	5.3	5.7	6.1
Tractive effort × diam. drivers ÷ equivalent heating surface*	1,088.3	705.0	765.0	842.1	717.4	638.3	621.9	642.0	628.0	642.1	713.0	532.1	676.4	578.9	794.5	568.0	669.0	558.5
Equivalent heating surface* ÷ grate area	102.9	85.7	82.6	69.1	74.9	89.4	82.4	76.5	93.8	91.9	77.3	92.8	74.1	78.9	71.8	76.0	73.7	94.7
Firebox heating surface ÷ equivalent heating surface*, per cent	5.0	5.3	6.5	4.5	4.8	4.6	5.0	6.5	4.2	4.9	55.6	4.8	5.2	4.3	6.7	7.0	5.7	3.9
Weight on drivers ÷ equiv. heat. surface*	82.2	53.8	59.6	66.4	46.0	42.3	41.5	40.2	39.8	44.3	48.5	40.3	44.3	38.6	52.6	40.6	46.2	41.8
Total weight ÷ equiv. heating surface*	92.1	64.1	72.0	72.0	61.1	56.7	55.4	52.8	53.5	56.7	57.7	52.4	60.2	50.6	67.8	52.3	64.2	54.5
Volume both cylinders	51.3	27.8	24.5	20.0	22.9	21.4	19.9	22.8	21.4	19.9	21.2	18.3	19.9	17.2	19.2	17.0	15.7	16.1
Equiv. heating surface* ÷ vol. cylinders	180.5	263.0	244.0	249.0	230.0	264.0	290.0	262.0	274.0	268.0	243.0	297.0	235.0	323.0	212.0	297.0	256.0	294.0
Grate area ÷ vol. cylinders	1.7	3.1	2.9	3.6	3.0	2.9	3.5	3.4	2.9	2.9	3.1	3.1	3.1	4.0	2.9	3.9	3.5	3.11
Reference to photographs, drawings or description	R.A.G.M.E.‡ 1914-p227					R.A.G.Jan. 1914-p86	R.A.G.M.E.‡ 1914-p343				Am. Engr. 1913-p525							R.A.G.M.E.‡ 1914-p172

* Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface. ‡ *Railway Age Gazette, Mechanical Edition.*

§ Includes combustion chamber heating surface. † Includes arch tube heating surface.

CAR DEPARTMENT

PORTABLE SCAFFOLD FOR CAR REPAIR TRACKS

BY E. W. HARTOUGH
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The illustration shows a portable scaffold which has been adopted at this point for use on repair tracks where the means of building a permanent scaffold are not available. The scaffold board is 12 in. wide and 10 ft. long and it will be noticed that there is a pair of drop handles at each end for use in moving the scaffold about the yard. When not in use these handles drop down beside the end frame where they are out of the way and in no danger of being broken off. At one end the legs are fitted with small rollers which facilitate moving the scaffold about. These rollers make it possible for one man to handle the structure and also protects the legs from being broken by dragging it about in adjusting it to the work.

It will be noted that the horizontal braces near the bottom which connect the two end frames are sprung in at the

Portable Scaffold with Rollers and Drop Handles

center and bolted together. This makes a much stronger brace than would two straight pieces and also leaves room for a man standing on the ground to work between the brace and the side of the car. It is of advantage in placing the scaffold around the corner of a car or across the end, where the coupler would interfere with a straight brace and make it impossible to get close to the end of the car.

SMOKE AS AN INDICATOR OF EFFICIENCY.—In burning oil as fuel, dense smoke may indicate that a very considerable proportion of the fuel is going to waste from imperfect combustion; but in burning coal a smoky chimney does not necessarily indicate serious inefficiency of firing, as the losses due to visible smoke seldom exceed 2 per cent. Dense clouds of smoke may result from the operation of a furnace with minimum air supply and incomplete combustion that will give a higher evaporation per pound of fuel than where the furnace is made smokeless by a larger excess of air, causing much greater losses of heat in the chimney gases.—*Power.*

NUMBERING REPAIR PARTS OF CARS

BY W. H. HAUSER
Mechanical Engineer, Chicago & Eastern Illinois

It has been standard practice for years for railroads to number all locomotive, car and miscellaneous castings with individual numbers and to issue a blue-printed or some

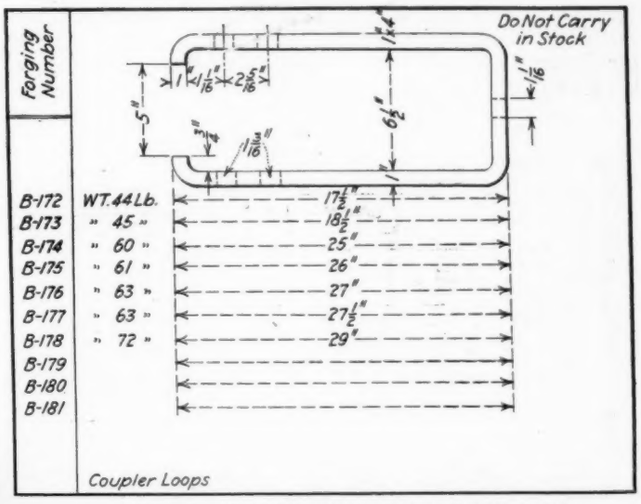


Fig. 1—Example of Classifying Detail Repair Parts

other type of pattern record to all storekeepers and foremen interested in the use of such a record. Some roads, on account of their size and the diversity of classes of power, have been forced to adopt quite complicated pattern num-

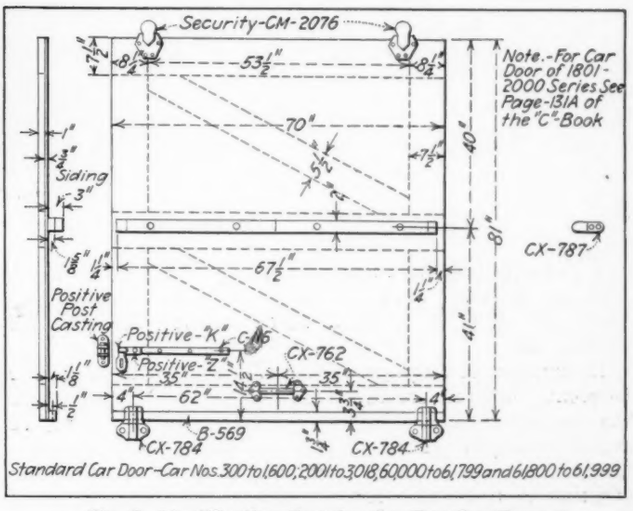


Fig. 2—Identification Drawing for Box Car Doors

bering systems. Other roads have found the simple numbers, with the prefixes as shown below, the most satisfactory:

L B 1000 meaning, a locomotive (L), brass (B), casting number 1000
L S 1000 meaning, a locomotive (L), steel (S), casting number 1000
L C 1000 meaning, a locomotive (L), cast iron (C), casting number 1000
L M 1000 meaning, a locomotive (L), malleable iron (M), casting number 1000

with the prefix (F) for freight cars, (P) for passenger cars, (T) for tools, and so on.

We have extended this system of record and numbers to

forgings, standard practices, steel work details and safety appliances of all kinds on freight and passenger cars. We have made up and issued to all storekeepers and freight car foremen a book named "Freight Car Forgings and Standard Practices." This book, in a convenient size of 10 in. by 14½ in., shows at least two forgings on each page. It is known to all men using it as the "B" book, since we use the prefix "B" in numbering freight car forgings. In the book are shown arch bars, brake levers, all kinds of brackets, hangers, loops, pins, rods, carriers, special bolts, etc. These are all shown in detail so that forgings can be made from the drawings. The size of material used and the weight per piece is also noted.

Fig. 1 illustrates the plan. B 172 to B 178 are miscellaneous 6½ in. coupler loops. They are not our standard, but cover sizes that are occasionally used. They are not carried in stock, and are to be made as needed. In case a car foreman orders a 6½ in. loop not shown on this sheet his storekeeper can immediately call his attention to the fact that probably save the making of a loop that is not wanted. Arch bar drawings are made for the different series of cars. Each bar has a "B" number which can be painted on the finished bar.

In addition to forgings wooden pieces or parts which are frequently ordered are identified in the same manner, and box car doors have been standardized and identified, as shown in Fig. 2. In the line of standard practices betterment drawings are outlined and sent to all car foremen, in addition to a circular letter. Many railroads have made Shop Card files which cover some of the ideas outlined above, but this "B" book form permits of more ready binding and through the consecutive numbering shows each holder of a book whether or not he has all drawings or "B" numbers of all forgings and other car data.

In addition to the "B" or forging book, a steel car detail book has been drawn up, called the "C" book. Fig. 3, drawing No. 7159 C, shows the end elevation of a car which serves as an index sheet in the "C" book. Other drawings show the "C" book details. These drawings are given numbers in addition to the "C" book numbers to facilitate ordering from manufacturing concerns. This book also permits of the store department painting these numbers on the pieces as they are received and checked and also to sort and file them for easy identification. The idea of steel details having "C" numbers and forgings "B" numbers greatly aids all concerned in efficient handling.

In addition to the above there are all the safety appliances forgings. These we give an "SB" number showing that they are safety (S) forgings (B). An assembly drawing shows all the various forgings and the application necessary to bring one of these cars up to U. S. Safety Appliance Standard requirements. Smaller sheets show the exact details of these forgings. They are made into a book 7¼ in. by 10 in. over all, including a binding edge.

Car men and storekeepers will appreciate how much such a simplified record means. There is no more ordering by name with each man using a different name. No ordering of forgings seldom used to lay in stock and eventually find their way back to the scrap dock. The men readily remember the simple numbers of the pieces most frequently used and talk and work with those numbers. If these records are kept up to date, and it can readily be understood that they are useless unless they are, the storekeeper's troubles are greatly lessened, the car foreman's hunt for the right piece is as nothing compared with having no such record, and the railroad is constantly the gainer through the use of correct forgings and no more overstock of useless forgings.

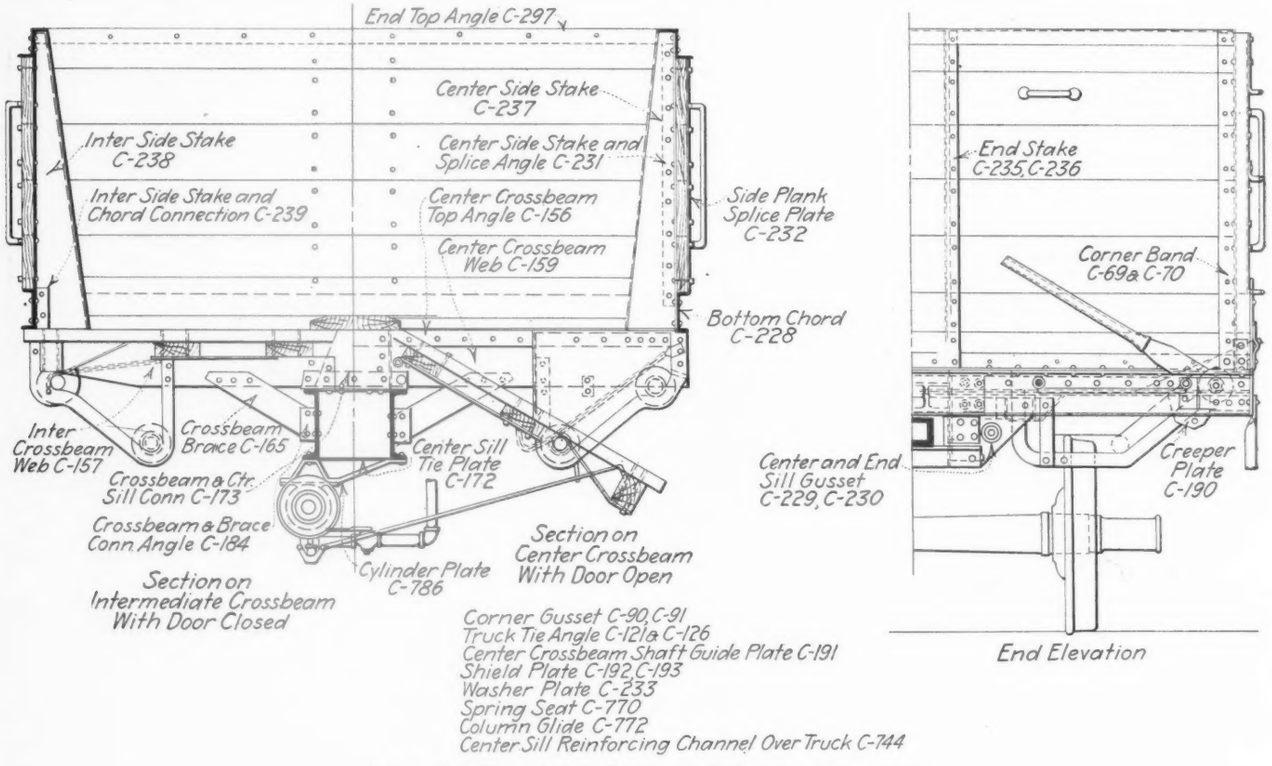
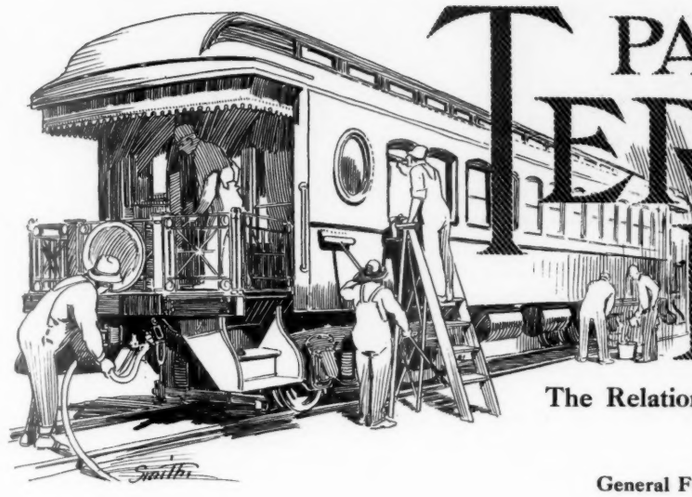

End Top Angle C-297
Center Side Stake C-237
Inter Side Stake C-238
Center Side Stake and Splice Angle C-231
Inter Side Stake and Chord Connection C-239
Center Crossbeam Top Angle C-156
Center Crossbeam Web C-159
Side Plank Splice Plate C-232
Bottom Chord C-228
Inter Crossbeam Web C-157
Crossbeam Brace C-165
Crossbeam & Ctr. Sill Conn C-173
Center Sill Tie Plate C-172
Crossbeam & Brace Conn Angle C-184
Cylinder Plate C-786
Section on Intermediate Crossbeam With Door Closed
Section on Center Crossbeam With Door Open
Corner Gusset C-90, C-91
Truck Tie Angle C-121 & C-126
Center Crossbeam Shaft Guide Plate C-191
Shield Plate C-192, C-193
Washer Plate C-233
Spring Seat C-770
Column Glide C-772
Center Sill Reinforcing Channel Over Truck C-744
End Stake C-235, C-236
Corner Band C-69 & C-70
Center and End Sill Gusset C-229, C-230
Creeper Plate C-190
End Elevation

Fig. 3—Sample of Index Sheet for Steel Car Detail Book

KEROSENE IN BEARINGS.—Kerosene oil has little or no lubricating property, but its use in bearings to remove gum and worn-out oil is an excellent practice provided it is flushed out with a liberal application of lubricating oil so that the bearings are left in a well lubricated condition to start. The fact that kerosene dissolves rust is no indication that it dissolves metal; it has little or no deteriorating effect on steel, brass, bronze or iron.—*Machinery.*



PASSENGER TERMINAL INSPECTION

The Relation of the Car Department to the Operation of a Large Passenger Terminal

BY R. S. MOUNCE

General Foreman Car Repairs, Erie Railroad, Jersey City, N. J.

[The following article was awarded the first prize in the car terminal competition which closed April 1. The author in writing it has adhered strictly to practical cases, the description dealing with the terminal yard of the Erie Railroad at Jersey City. The second prize was awarded to J. E. Ross, master painter of the New Orleans, Mobile & Chicago. This article, together with others submitted in the competition, will be published in early issues.—EDITOR.]

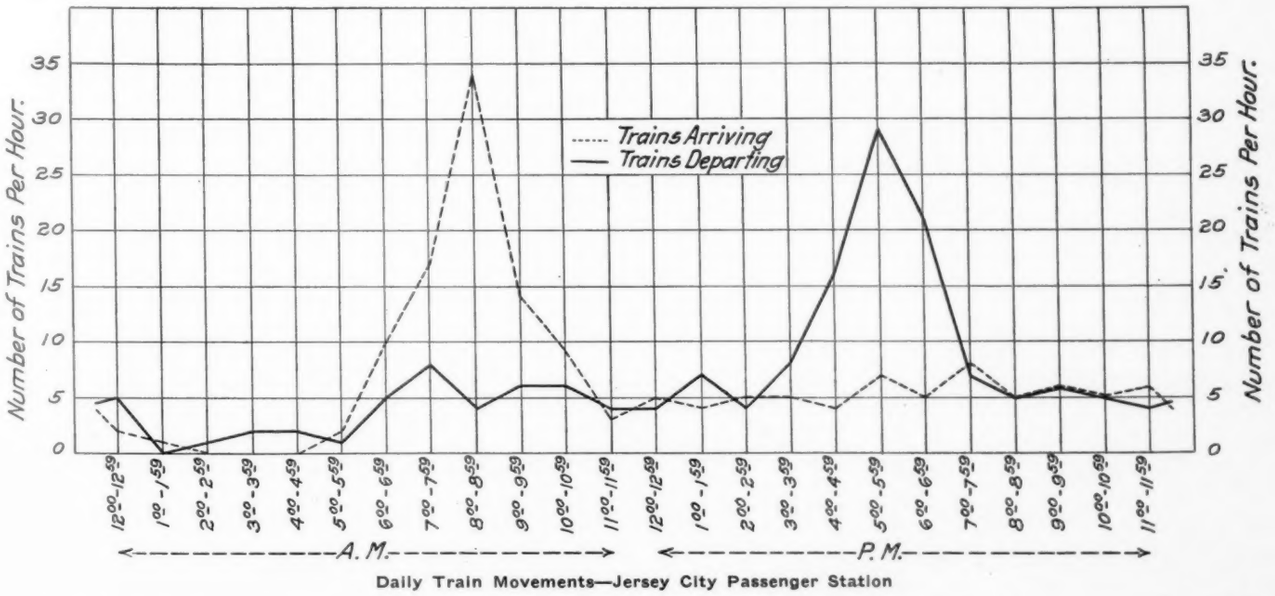
The operation of the Jersey City passenger terminal of the Erie Railroad presents some unusual problems, mainly because of the nature and volume of the traffic handled in the limited space available. All movements follow a carefully planned schedule, and the mechanical and operating departments work in such close harmony that the combination forms a single well-rounded organization. The discussion which follows briefly outlines the method of preparation and the operation of passenger trains at this terminal during the 24 hours of an ordinary week day in the winter season.

NUMBER AND NATURE OF TRAINS

During a period of 24 hours a total of 317 regularly scheduled passenger trains arrive at and depart from the Erie station at Jersey City over the main line and four side lines according to the classification which follows. From this statement it is seen that 89 per cent of all the trains operated are used in suburban traffic:

	Arrive	Depart
Through trains, Buffalo, Cleveland, Cincinnati & Chicago	4	4
Wells Fargo express trains, transcontinental	1	2
Milk trains	5	4
New York division trains	8	7
Suburban trains:		
Main line, proper	31	39
Main line, Newark branch	16	14
Northern R. R. of New Jersey	22	22
New Jersey and New York R. R.	20	20
Greenwood Lake division	26	26
New York, Susquehanna and Western	24	22
Total suburban trains	139	143
Total all services	157	160
Grand total, trains arriving and departing	317	

The diagram shows the number of trains arriving at and departing from the station during each of the 24 hours. Between the hours of 7 and 10 a. m., 65 trains arrive and 18 depart, and between 4 and 7 p. m., 66 depart and 16 arrive. Taking the trains out of the 12-track train shed to the various storage yards during the morning rush hours, and bringing them back again for the evening business without interrupting scheduled train movement, is a complicated problem which, from the nature of this discussion, cannot be described here.



Daily Train Movements—Jersey City Passenger Station

The daily passenger train car movements out of the sta-

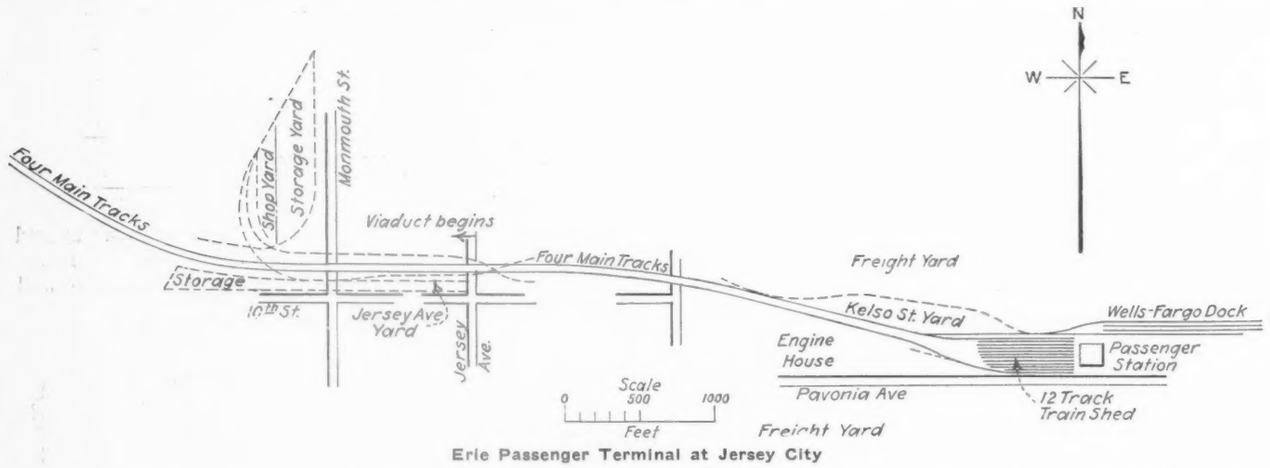
tion approximate more than 900, subdivided into the following classes:

Commuter coaches and combined cars	775
Through-line cars, including coaches, Pullman, dining baggage and mail cars	35
Through-line Wells Fargo express cars	20
Local express cars	30
Milk cars	50

The accompanying map shows the location of the several passenger car storage yards in relation to the station. Kelso street yard is located just north of the train shed so that a minimum amount of switching is required to place trains there. There are 70 trains handled in this yard during the 24 hours. The two Wells-Fargo trains are prepared and loaded on the Wells Fargo dock, which is adjacent to and north of the passenger station. Here also express cars for through line and local trains are handled. One short track at the head of the dock is used for the preparation of mail cars.

At Jersey avenue yard coaches, combined cars, diners and Pullman cars used on through line trains, as well as parlor cars and coaches for six local trains, receive the necessary attention. At the west end of this yard storage room is provided for extra coaches, Pullman and parlor cars. One portion of this end of the yard has an enclosed space with track room enough for the several business cars.

Monmouth street yard is located opposite Jersey avenue yard, north of the viaduct. It is divided into two parts, a shop yard with 5 tracks, and a storage yard with 19 tracks. There are 34 trains handled at the storage yard, the majority of them being placed there after the morning rush and remaining there until required for the heavy evening business.



Erie Passenger Terminal at Jersey City

The remaining trains, with the exception of milk trains, are handled by what are termed "relay" and "quick turn" movements, there being 23 "relay" and 17 "quick turn" trains. Immediately after a "relay" train reaches the station, its locomotive is uncoupled and moved a few feet away from the head car. Shortly afterward another locomotive backs down to the other end of the train and couples on ready for departure. After the arrival of a "quick turn" train, it is backed to the engine yard. The locomotive is then uncoupled and taken over the turntable, after which it is coupled to the other end of the train. The train then backs to the train shed and soon departs on its trip.

The four milk trains are loaded and prepared at the local freight yard south of Pavonia avenue. Three of them are afterward placed in the passenger train shed on account of their including coaches.

CAR DEPARTMENT ORGANIZATION

The force necessary to handle the inspection, maintenance, heating, lighting and cleaning of the passenger equipment required for these trains numbers about 300 persons, including supervision. All of this work comes under the direct charge of the general foreman car repairs, with a staff of several foremen. The station, Kelso street yard and the Wells-Fargo dock are looked after by one foreman with the aid of two assistant foremen, one of whom devotes his entire time to the express and mail cars, while the other attends to the station work and milk trains at night. Jersey avenue yard has one foreman, and Monmouth street yard has two, the one at the shop and the other in charge of the storage yard. All air brake inspectors at the several yards report directly to the yard foremen and indirectly to the air brake foreman, who gives the greater part of his time to the inspection and testing of brakes on trains arriving at and departing from the station. The foreman of electric car lighting has charge of all work on electrically lighted cars, including inspection and repairs to generators and storage batteries.

INSPECTION

All trains receive a running inspection while passing into the train shed, in order that flat wheels or any part which is dragging may be most easily detected. All through line trains, and commuter trains which remain there long enough are given a standing inspection before being taken to the layover yards. Any part found defective is marked with chalk and if the repairs will require several hours work or are of such a nature that the car will have to go over a wheel pit or be jacked up, shop marks are applied and the car is taken to Monmouth street shop. Minor repairs are made in Kelso street repair track or in the several storage yards. After trains are placed in the storage yards, a yard inspector goes over them again, locating any defects which were overlooked at the station. Express cars used on the Wells-Fargo trains, and mail cars are handled on the dock, where they receive most careful inspection on account of the exacting nature of these classes of service. Milk cars are inspected and minor repairs made in the freight yard.

The interiors of all coaches and combined cars are inspected daily by an experienced carpenter, who makes written report to the yard foremen regarding defects in seats, windows, deck sash, toilets, doors, steam heat appliances and any other defects reported by the train crews. Before departure from the station, all trains are given a standing air brake test by the air brake inspectors. At the same time air signals are tried and steam train lines examined.

MAINTENANCE

Minor repairs to all passenger cars are made in the storage yards by car repairers assigned to follow up the yard inspectors. Carpenters go through all trains taking care of work reported by the interior inspector and watching

for other defects which may have been previously overlooked. Air brake inspectors go over trains daily, examining air and steam train lines and hose, and cleaning cylinders and changing triple valves when they are out of date. They also make daily tests of brakes on all trains, adjusting piston travel when necessary, and trying the hand brakes periodically.

Heavy running repairs, such as change of wheels, journal boxes or pedestals; raising car bodies and other work requiring the use of jacks; platform, buffer or draft gear repairs; steam and air pipe work, and other similar repairs which will not hold the car out of service an undue length of time, are handled at Monmouth street shop. Cars requiring repairs of too extensive a nature for the somewhat limited facilities available are sent to the nearest general repair shop.

Through line, express and mail cars have all journals and journal bearings thoroughly inspected and the packing carefully examined and adjusted before each trip. All other cars receive this attention at regular and frequent periods.

HEATING AND LIGHTING

During the cold weather all trains, with the exception of certain cars held in the shop yard, are placed on steam while lying over in the yards. A power house, located just west of Monmouth street yard, equipped with three 300 hp. water tube boilers, supplies Monmouth street and Jersey avenue yards. Another power house, located near the station, furnishes steam for Kelso street yard, the Wells-Fargo dock and the station. Daily inspection of cars while under steam permits of keeping train line valves, steam hose and supply valves in good serviceable condition.

A large number of cars are lighted by Pintsch gas. All storage yards and the train shed are provided with gas lines and connections, making it possible to supply gas to cars with but little trouble on account of switching. Gas checkers take readings of the gas gages on all cars and, in the case of local cars, if the pressure has dropped to a specified minimum, the reservoirs are charged to a certain maximum pressure. Through line cars are supplied with gas to the full line pressure every trip, regardless of the initial gage pressure. Regularly assigned men inspect and repair the gas lamps.

About 225 electrically lighted cars, in both through and local service, are operated. A portion of these cars in both classes of service are equipped with axle generators and the others with straight storage batteries.

Two inspectors go over the electric lighted cars on arrival, except in the case of axle light local cars which are inspected once daily regardless of the number of trips made. The first inspector reports all defects and replaces burned out or missing lamps and fuses. The second inspector reads the voltage on all cars, marking for charging those cars whose batteries are found with voltage at or below the specified minimum. All dining and mail cars are carefully inspected and repaired after arrival by electricians assigned to this work.

Storage battery cars which require charging are handled either at Jersey avenue or Monmouth street yards, where charging plants are located. Several pairs of tracks in each yard have third rails placed between them for carrying the charging current to the cars, connection being made from the third rail to the receptacle on the car. The current is returned to the charging plant through bonded service rails and underground cables. Two men operate each plant and charge the cars in the respective yards. These men are required to keep all cells flushed and to report defects in batteries or connections. Defective cells are located by electrolyte and voltmeter test. The repairing and cleaning of batteries is handled by a gang of four men, stationed at Monmouth street shop.

When the batteries of axle light cars require charging, the cars are taken to the western end of Jersey avenue yard, where a small charging machine and the electricians' shop are located. The periodic washing of batteries is looked after at this point.

CLEANING

About 140 car cleaners are required to take care of the cleaning of the equipment. Nearly all of this work, except the cleaning of relay trains, is done on a piece-work basis, insuring close adherence to time schedules, which is most necessary at a terminal when so many trains are handled. The sanitary condition of the cars is also a matter of prime importance.

All layover local coaches are swept and dusted; have their floors mopped with water containing disinfectant; toilet hoppers disinfected; lamps, globes and windows cleaned, and vestibules and hand rails cleaned, daily. Relay cars are swept, mopped and dusted after every trip, and held over at least once in ten days for a thorough cleaning of both interiors and exteriors. Exterior scrubbing of car bodies is given at regular intervals and dry wiping is done between scrubbings. Renovating interior woodwork, renovating plush seats, cleaning headlining, scrubbing toilets, scalding water coolers, and the vacuum cleaning of seats are operations which are performed periodically.

Through line coaches, Pullman, dining, parlor and mail cars are thoroughly cleaned both inside and outside after every trip. Certain of the above-mentioned periodic operations are not done so frequently.

The successful maintenance and operation of the equipment required to handle the large passenger business of the Erie Railroad in and out of its Jersey City terminal are the result of close co-operation and complete harmony, not only between the division operating officers and the local head of the car department, but also between the members of the car department staff. Close attention to the mechanical condition of the equipment and systematic care of every detail, bring about a reasonably satisfactory solution of a necessarily complex problem.

THE SANITATION OF RAILWAY CARS*

BY THOMAS R. CROWDER
Director of Sanitation and Surgery, The Pullman Company

One of the things through which disease is most readily transmitted by the indirect route is the common drinking cup. Infected lips leave bacteria on the rim, and well lips pick them up. Ten years ago the common cup was universal on railway trains; now it is a thing of the past. Thanks to the initial temerity of Kansas in 1907, a reform was started which has now become complete. The common towel was another very great evil. It has gone the way of the cup. The comb and brush, while less important, should be induced to make a similar exit.

Ample provision should be made in all railway cars for travelers to wash their hands and faces. Lavatories should be conveniently located, supplied with an abundance of water, well drained and trapped, and should have smooth surfaces for easy cleaning. Towels should be constantly at hand and in sufficient quantity for individual use. There should be a place for brushing the teeth—a dental lavatory—in all cars which make long journeys. Using a wash basin for this purpose is to make a cuspidor of it.

Toilets should be always available, well flushed, perfectly emptying, and capable of easy cleaning. The old type of open hopper, with its up-draught of wind and dust and its nearly constant fouling, is disagreeable, and its use is avoided to the detriment of the health of passengers. Cuspidors should be provided that spitting may not become an

*From a paper read before the New York Railroad Club, April 21, 1916.

insanitary nuisance. The disinfection of toilets and cuspidors is largely esthetic, though it is often insisted upon by laws and regulations. What goes into them is well disposed of; it is not touched, cannot fly into the air, and does no harm unless it becomes a nuisance to sight or smell, when immediate remedies are demanded. The fallacious drip-machine—the so-called continuous disinfector—made so popular by the inspired commercial tongues of pseudo-scientists, should be mentioned only to be condemned. It does not disinfect; it only distils an odor, sometimes worse than the one it tries to hide, and diverts attention from conditions that need mending.

Day coaches should have cans for garbage and refuse. Not that garbage and refuse carry infectious diseases—that is one of the fallacies of popular thought—but particles of food and other rubbish may be picked up from a dirty floor by children, or from a cuspidor on which it lodges.

An ample supply of pure and wholesome drinking water should be supplied and stored in such a way that it cannot readily be contaminated by passengers. Ice that goes into the water should be also pure and clean and should not be handled with bare hands. Better yet, ice should not go into the water at all, but into a separate compartment of the cooler. Such an arrangement is now required by some of the states and is being carried out by numerous corporations where there is no regulation. It is standard on many railroads and in the Pullman service.

In addition to providing for the sanitary arrangements outlined above, the roads have another duty: to instruct their employees in the principles that govern the protection of public health, to make rules for their sanitary guidance, and to see that these are obeyed.

It is of course desirable that the railroads should take precautions to keep infection down to a minimum. This may be done in two ways: by mechanical cleaning which removes the bacteria, and by fumigation which kills them. Of the two methods, the former is much the more important. Mechanical cleaning will not remove all the bacteria—for it cannot remove the last particle of dust and dirt in which the bacteria are contained—but if it is well done not enough will remain to hold out any danger to passengers.

The method used in the cleaning of cars is of less importance than the result obtained, which must be reasonable cleanliness in all instances. For bare floors, toilets, woodwork and utensils, soap, water, and elbow-work are the important ingredients which must enter into the process. For dislodging dust from corners and angles an air blast is both rapid and efficient. For removing it from carpets and fabrics the vacuum process is best; it not only removes the dust but collects it for final and quick disposal instead of scattering it about. But vacuum cleaning without sufficient power is a makeshift. Some two years ago, as a member of a committee to investigate car cleaning, I went through this subject in an experimental way. In the beginning there was no vacuum machine on the market which was well adapted to the work in car cleaning yards, but one was soon developed which did better cleaning than the compressed air process and did it cheaper, as has been amply verified by two years of practical application in Pullman service.

Fumigation is a procedure which has been much overworked in the past. Ten years ago there was an epidemic of state Board of Health regulations requiring it at frequent periodic intervals. If properly carried out, there is no doubt that fumigation will kill the vast majority of the bacteria in a car; but it is not a proper substitute for thorough mechanical cleaning, after which not enough bacteria will remain to be of any real hygienic significance. In recognition of this fact the movement for periodic fumigation is now dying out: the tendency is rather to require it only after serious infectious diseases are known to have been carried, as is done by the new Interstate Quarantine Code. No objection should be made to that demand, even though the good it does is questionable and problematic.

Ventilation is a vital sanitary problem. Good air is of prime importance to good health. Ten or twelve years ago, attempts to supply good air to railway cars were generally failures. The problem seemed complicated and almost hopeless. It still has its difficult points, but thanks to the enlightening research of the last ten years it is now much simplified. We have learned what good air is: it is air that bears a proper thermic relation to the body. It must be able to absorb the body heat as rapidly as formed, without being cold enough to produce chilling. It must be warm, but not too warm; it must have motion, but not enough to cause discomfort; it must be changed constantly to prevent stagnation and overheating. The chemical changes brought about by respiration are ordinarily negligible.

Due to the high wind pressure to which running trains are constantly subjected, a surprising amount of air enters them even when no special provision is made for it. I believe the quantity can always be kept adequate by the application of a simple exhaust system, as is now done on many lines. A more difficult problem than maintaining the air supply is the proper control of heat. If the temperature is carefully regulated to between 65 and 70 deg. F., complaint of poor ventilation will rarely arise, even with impure air and a very small supply. Above 70, trouble comes quickly; we think there is not enough air to keep our lungs flushed out. That is not the trouble at all, for let the air supply remain the same and the temperature drop to the lower sixties and we think there is too much. The income and the outgo create air motion within. When the temperature is high we need more motion, hence a larger air supply, to keep the body cool; when it is low we need less motion, or a lower air supply, to keep the body warm. But the lungs and the function of respiration have nothing to do with this; it is entirely a surface function; and that is what ventilation is for—to act on the surface of the body and carry away its heat.

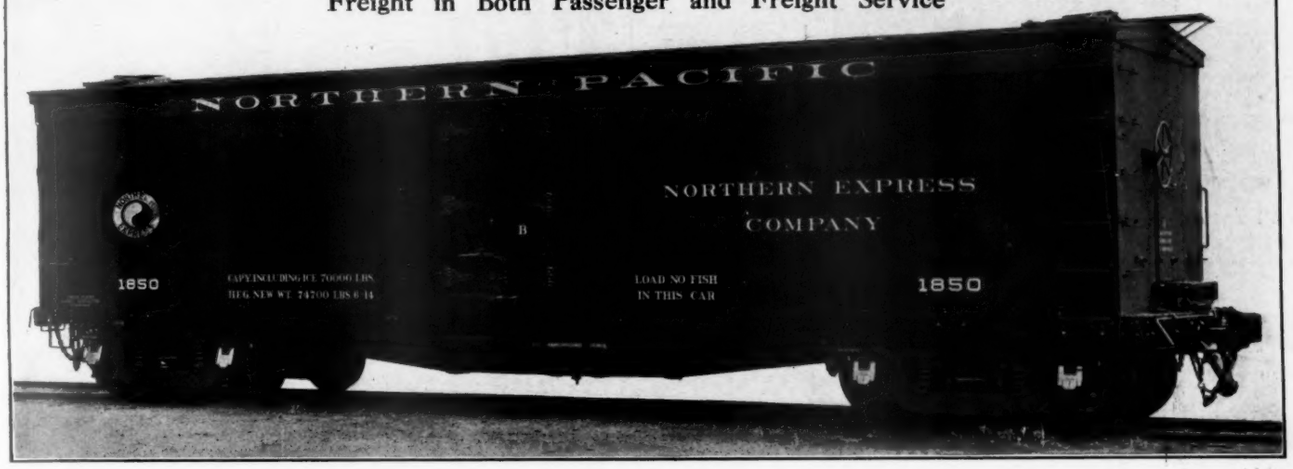
With a simple exhaust system of ventilation, specific air inlets are not necessary unless cars are greatly crowded. Natural crevices, to which may be added open sashes in the end doors, will be sufficient. For supplying artificial heat, direct radiation is better than indirect. Little cold streams of incoming air, mixing with the warmer and stiller body of air within, contribute to the stimulating variations of surface environment which are necessary to comfort and health. Only when large quantities of cold air are admitted at one place is heating of the incoming stream desirable, and this is not a good plan for ventilating railway cars. When no artificial heat is needed, as in the warm summer months, nothing can take the place of open windows; for large streams of rapidly moving air are necessary to maintain the thermic balance of the body.

A certain amount of dust, smoke and engine gases inevitably enters cars. They are, of course, liable to great variation. Smoke and gases are never troublesome except in passing tunnels, when they produce no more than temporary discomfort. I have examined many specimens of tunnel air and have found the gases of combustion always far below the point of danger. Ordinarily only the heavier particles of smoke—the small cinders—enter the car, the lighter solid particles and gases floating up and away with the wind.

Ordinary dust is of more importance because it is more prevalent and because it is possibly infectious. If not infectious it is at least irritating and uncomfortable, and prolonged breathing of a heavily dust-laden air predisposes to infections of the respiratory tract. Its sources from within the car should be limited by good cleaning, which is now generally satisfactory. When this is well done, carpets and plush are better than bare floors and smooth upholstery because they hold the dust that settles on them and prevent its redistribution to the air of the car.

NORTHERN PACIFIC EXPRESS CARS

Designed for the Transportation of Perishable Freight in Both Passenger and Freight Service



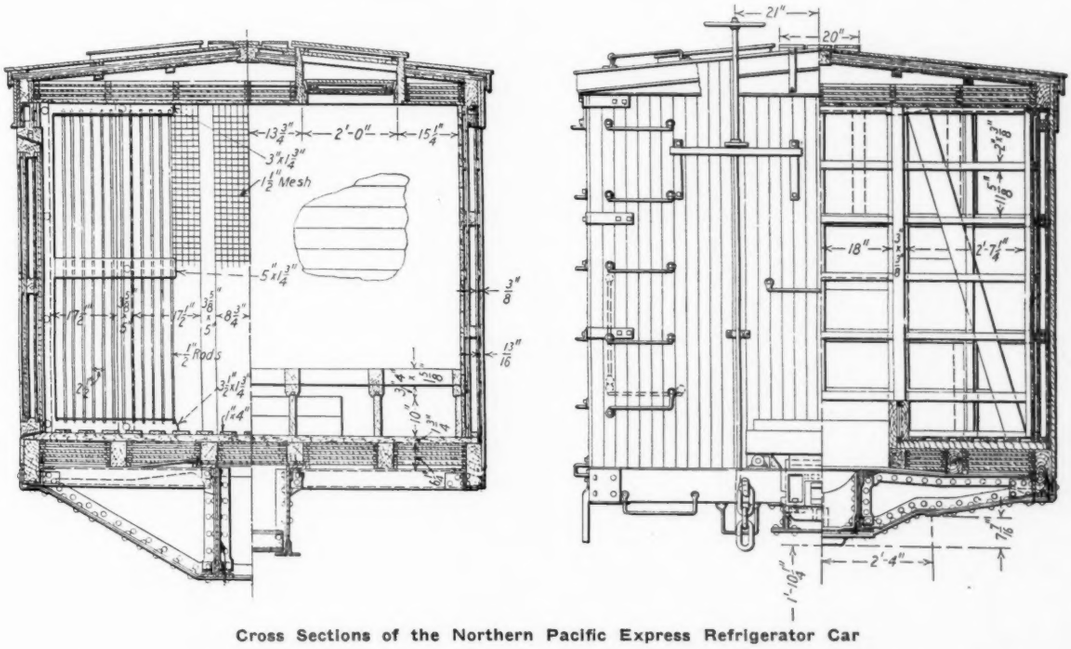
Northern Pacific Refrigerator Express Car

THE Northern Pacific is called upon to transport large quantities of berries, cherries and other fruit from the states of Washington, Idaho and Oregon, to many distant inland cities, the cherries being shipped as far East as New York, Boston and Philadelphia. A considerable amount of fresh fish obtained from the fisheries in the Northern Pacific and Alaskan waters is also transported to inland and Eastern points. In order to insure prompt and expeditious delivery at such distant points special passenger refrigerator cars are required. Forty of these cars, which have given very satisfactory service as refrigerators and as cars were built for this road by the Pressed Steel Car Company from the designs and specifications of the railway company. The cars were designed to be used in both passenger and freight service and have some interesting features of construction.

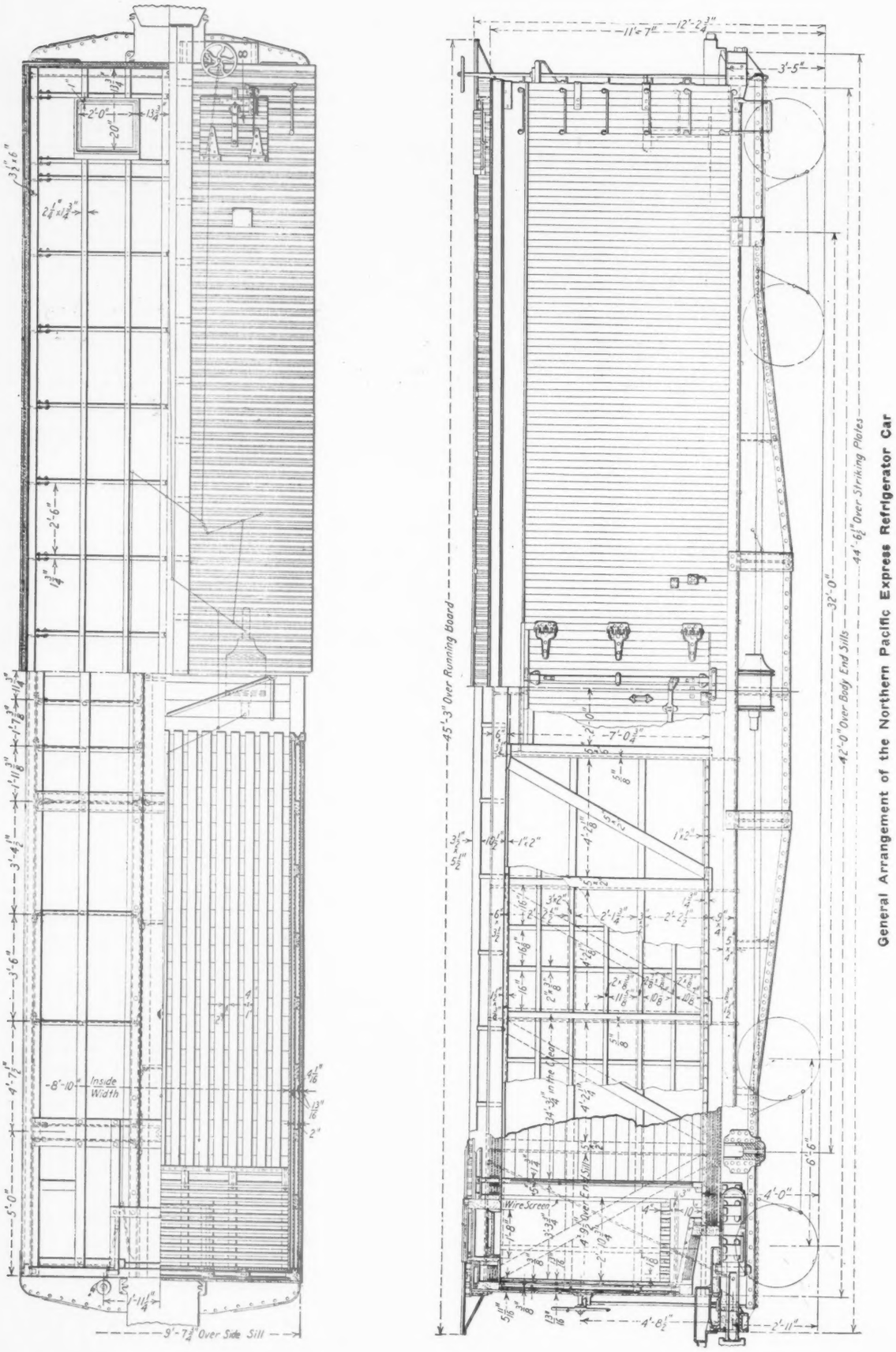
When used in passenger service they are placed at the head end of the train, which made it advisable that the strength of the underframe be equivalent to the United States railway mail service requirements for steel postal cars. It was also necessary to apply a spring buffing arrangement, which, when the cars are used in freight service, can be easily and quickly taken out of service. These cars have a light weight of 74,700 lb. and have a capacity of 70,000 lb., including 10,000 lb. of ice. The following are their principal dimensions:

Length over sub-end sills	42 ft.
Length inside	41 ft. 2⅛ in.
Length inside, between ice boxes	34 ft. 3⅛ in.
Width inside	8 ft. 10 in.
Distance between floor and ceiling	6 ft. 11 in.
Bolster centers	32 ft.
Top of rail to top of running board	12 ft. 2¼ in.
Width over sheathing	9 ft. 9⅛ in.

The cars are designed to pass safely over curves of 150

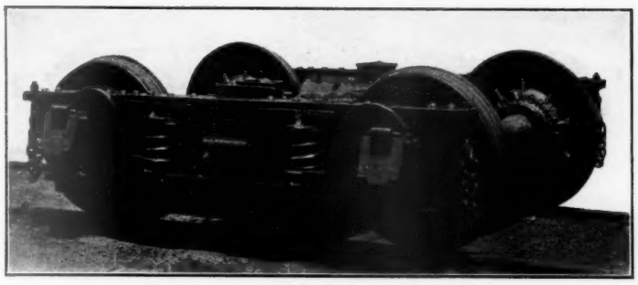


Cross Sections of the Northern Pacific Express Refrigerator Car



General Arrangement of the Northern Pacific Express Refrigerator Car

ft. radius, and are built to conform to the New York City electric zone clearances and the American Railway Association's clearance for third rails. They are designed to carry a live load of 70,000 lb. plus 10 per cent overload in addi-

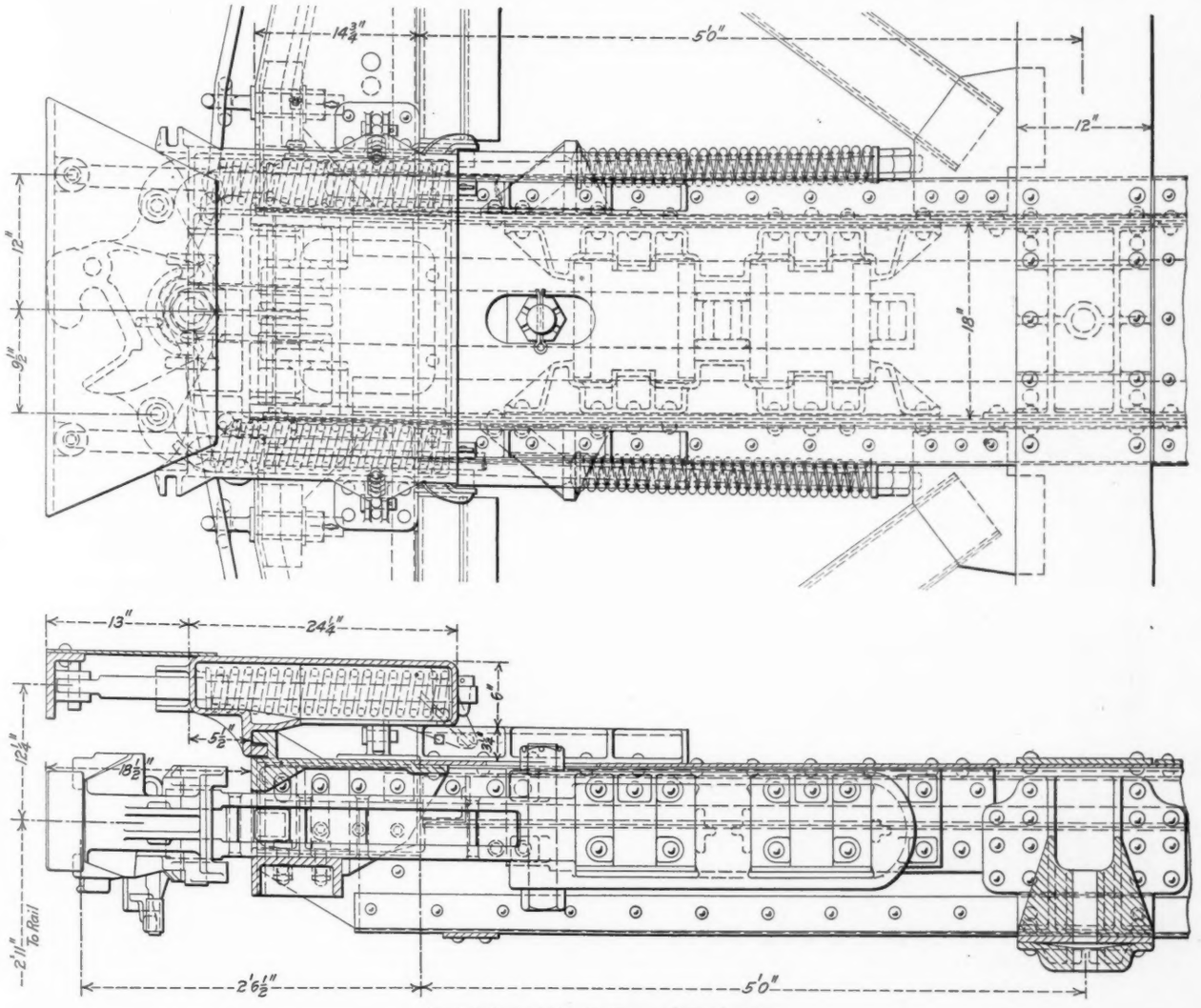


Four-Wheel Truck for the Northern Pacific Express Cars

tion to the dead weight plus the usual 50 per cent allowance for shocks and oscillations. The steel underframe is similar to that used on the 60-ft. steel postal cars in use on that road and is designed to withstand a buffing shock of 400,000 lb. applied as a static load.

The center sills are of the fishbelly type, 28 in. deep at the center. They are composed of 5/16 in. vertical web plates located 18 in. back to back with 3½-in. by 3½-in. by 7/16-in. angles at the bottom (inside and outside), 3½-in. by 3½-in. by 7/16-in. angles at the top on the outside, one 26-in. by ¼-in. cover plate extending from end sill to end sill, and one 26-in. by 7/16-in. cover plate extending from bolster to bolster. The center sills are 15½ in. deep at the bolsters. The side sills are composed of one 5-in., 11.6-lb. Z-bar and one 5-in. by 4-in. by ⅜-in. angle. The bolsters and crossbearers are of the built-up type consisting of web plates reinforced by angles at the top and bottom and by cover plates. The platform end sills are composed of channel sections with cover plates at the top and bottom. The car body is of wooden construction consisting of 5-in. by 6-in. oak door posts, 5-in. by 5¾-in. oak corner posts, 2-in. by 5-in. fir side posts, 2-in. by 5-in. oak end posts, and 2-in. by 5-in. fir side and end braces. There are two 2-in. by 3-in. belt rails, and eighteen 1¾-in. by 10½-in. carlines.

The arrangement of the buffing device is shown in the accompanying drawings. The buffing springs are encased in a cast steel housing which is held in either the "in" or "out" position by toggle bolts fitting in the lugs at the corners of the housing. When in the "out" position the thrust on the buffer is transferred to the draft gear housing by means of interlocking lugs cast on both the buffer and draft gear housings, as shown directly underneath the front of the buffer housing. When in the "in" position the buffer hous-



Application of the Buffer and Draft Gear

ing rests on a bed plate and is well inside of the car in a recess built under the ice grates, as shown in the sectional elevation. A sliding door is provided on the end of the car to cover the recess when the buffer is in the "in" position. The time consumed for changing the buffer from one position to the other, either for freight or passenger service, is from 10 to 15 minutes.

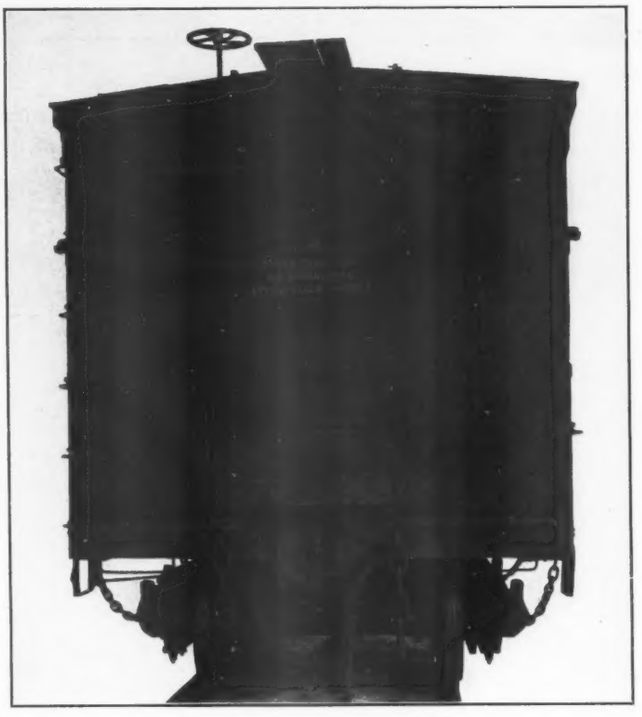
Sectional air space insulation for the walls, floor and roof is similar to that of the freight refrigerator cars built for this road in 1913. The accompanying table gives a detailed description of the insulation construction (from the inside of the car in the order shown).

INSULATION

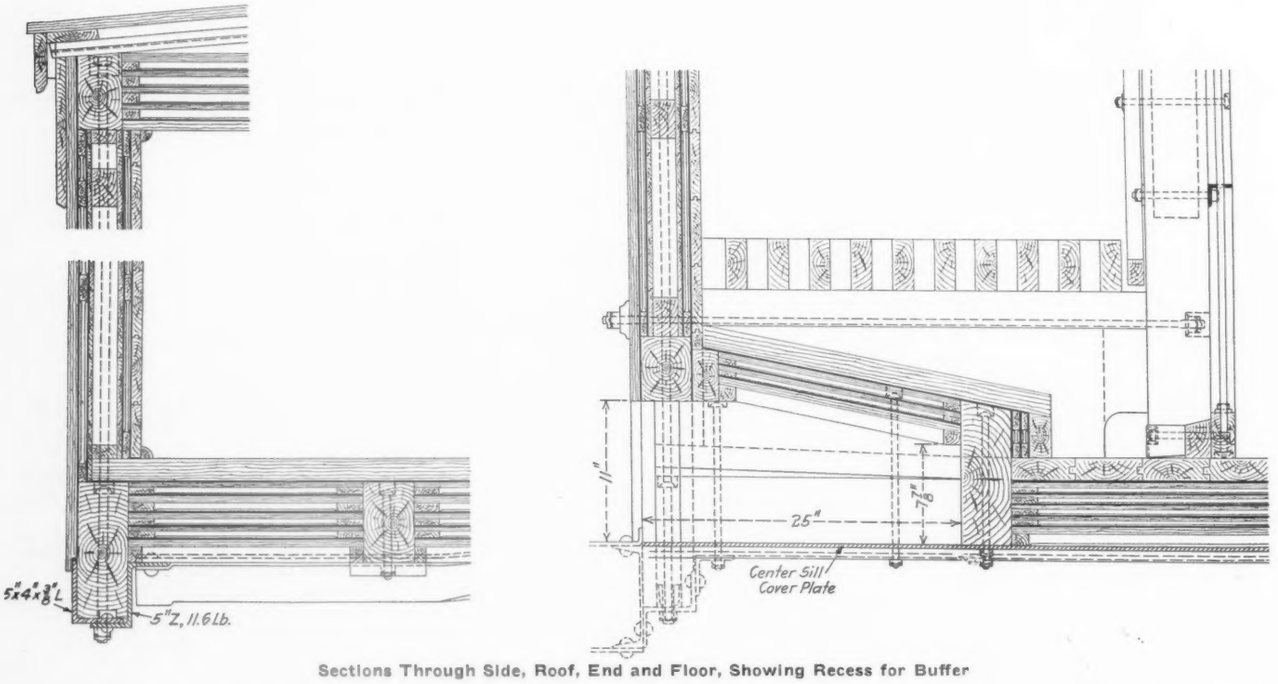
Floor	Walls	Roof
1¾-in. flooring	13/16-in. lining	13/16-in. ceiling
90-lb. Neponset paper	90-lb. Neponset paper	90-lb. Neponset paper
1½-lb. wool felt	1½-lb. wool felt	1½-lb. wool felt
⅜-in. ship lap	⅜-in. air space*	Air space
½-in. air space	1½-lb. wool felt	⅜-in. ship lap
90-lb. Neponset paper	90-lb. Neponset paper	90-lb. Neponset paper
1½-lb. wool felt	⅜-in. ship lap	1½-lb. wool felt
⅜-in. ship lap	2-in. air space	Air space
½-in. air space	⅜-in. ship lap	⅜-in. ship lap
1½-lb. wool felt	90-lb. Neponset paper	1½-lb. wool felt
90-lb. Neponset paper	1½-lb. wool felt	90-lb. Neponset paper
⅜-in. ship lap	⅜-in. air space*	Air space
½-in. air space	1½-lb. wool felt	⅜-in. ship lap
1½-lb. wool felt	90-lb. Neponset paper	1½-lb. wool felt
90-lb. Neponset paper	13/16-in. sheathing	90-lb. Neponset paper
⅜-in. ship lap		Air space
½-in. air space		⅝-in. sub roof
1½-lb. wool felt		90-lb. Neponset paper
90-lb. Neponset paper		Paroid plastic roofing
⅝-in. dead floor		Sub-carlines, 9/16 in.
		Sub-purlins, ⅞ in.
		13/16-in. roofing

*In the ⅜-in. air spaces in the walls vertical and horizontal flat wooden strips ⅜ in. thick are provided to cut up this air space into small sections, thus making these air spaces as near "dead" as they can be made by the careful fitting of wood to wood. In addition, these strips serve to hold the wool felt in place.

There is an ice box at each end of the car having an ice capacity of 5,000 lb. The Bohn syphon type fixed bulkhead is used. In addition to the usual ice pan drainage, drainage is also provided for the floor. The Miner tandem spring draft gear is used with one M. C. B. class G and one 8 in. by 8 in. Harvey friction draft spring in each gear. The cars are provided with the Westinghouse schedule LN-1412 air brakes. Cast steel parts, instead of forgings are used wherever practicable. The railway company's standard four wheel equalized trucks are used, having a wheel base of 6 ft. 6 in. and 5½ in. by 10-in. M. C. B. journals. The bolsters are steel castings and the spring planks are made up of two 6-in. by 4-in. by ⅜-in. angle bars. The bolster springs are triple elliptic and the equalizer springs are coil springs of the M. C. B. standard class G. The wheels are 34¼ in. in diameter with 3⅛-in. steel tires. The brake beams are of the Davis high speed solid truss type.



End View, Showing the Buffer Arrangement



Sections Through Side, Roof, End and Floor, Showing Recess for Buffer

THE CAUSE OF SLID FLAT WHEELS*

The relation of slid flat wheels to uniform retardation, or rather the lack of it, is not generally apparent. In the first place it is well to review the influence of adhesion or wheel-rail friction on the braking problem. Fig. 1 shows a locomotive driver with the crank pin on the top quarter and the force applied by a horizontal cylinder with a main rod of infinite length. As long as the wheel doesn't slip, it is evident that the wheel moves about the point of contact of the wheel with the rail as fulcrum. A line joining the crank pin with this fulcrum point may be considered as a simple lever of the second class. The delivered force appears at the center of the wheel and is the force which moves the train. Strictly the net force serving to move the train is the difference between the delivered and applied forces, because the reaction of the steam acting against the back cylinder head is exactly equal and opposite to the applied force on the piston and is applied through the locomotive frame to the center of the wheel and directly opposes the delivered force. This difference between the two forces sets up a thrust of the wheel to the left against the rail, which thrust is equal, of course, to the force difference causing it. This thrust of the wheel on the rail is exactly equaled and opposed by the thrust of the rail on the wheel. That is, action and reaction are always equal and opposite. With reference to the ground this thrust of the rail on the wheel is the force which, applied from a point external to the locomotive, moves it. *If this is only remembered it will be easy to visualize the effect of the rail on the train when the brakes are applied.* Now, if the locomotive be reversed, which means also reversing the forces, as indicated by the dotted lines, a retarding force is set up and finally applied by the rail to the wheel in a direction opposed to the motion of the train, according to the sequence above pointed out.

Plainly, if the fulcrum, or point of purchase, at the contact of the wheel with the rail, should fail, the drivers will slip and the train fail to move—or at least fail to be accelerated except for an amount equal to the kinetic friction, or friction of relative movement, between wheel and rail. The value of this kinetic friction is far less than the static or rolling friction, which is most frequently termed "adhesion." This failure of the fulcrum occurs when the thrust of the wheel on the rail exceeds the adhesion between the wheel and the rail. This adhesion is generally taken as 25 per cent of the weight resting on the rail. With a good dry condition of tread and rail surfaces 30 or 35 per cent may be the limiting value, and, on the other hand, the adhesion may drop to 15 per cent or less if the surfaces are slippery, due to frost, etc.

Now consider Fig. 2. The crank pin has been shifted 90 deg. and the cylinder placed vertically, something like a walking beam engine for a river boat. With reference to the engine the pin is still on the quarter. The lever now becomes instead of the straight line lever of Fig. 1, an offset lever; otherwise Figs. 1 and 2 are much the same. Were the crank pin shifted to the tread of the wheel the engine stroke would equal the wheel diameter and the same applied force would be much more effective in moving the train. The lever would now be a 1 to 1 lever; that is, the power arm and weight arm would be equal.

That is just the condition of affairs in Fig. 3. The applied force is the force of friction of the brake shoe, applied at the tread of the wheel, and this is a 1 to 1 offset lever with the fulcrum at the point of contact of wheel with rail. The delivered force at the center of the wheel opposes the motion of the train. It is equal to the applied force, which, in turn, is equal to the braking ratio (actual) times the weight on the wheel times the coefficient of brake shoe friction. It is also equal to and agrees in direction with the thrust of the rail on the wheel. As before noted, this is limited in value by the adhesion between wheel and rail.

If a car in motion and with the brakes applied suffers impact in a direction such that the car is accelerated, the rotative speed of the wheels will be increased also. But to accelerate the wheels a certain thrust is required from or of the rail. This is in addition to the thrust caused by brake shoe friction. If the sum of the two thrusts exceeds the adhesion the wheel will slide. The impact lasts a very short time only, and the rail thrust brought into play by this impact lasts only as long. But brake shoe friction in this very short interval of time has jumped up in value, becoming static where it was kinetic before, and the wheel-rail friction has dropped in value, becoming kinetic where it was static or rolling before and the wheel continues to slide. In other words, the impact has "knocked the car off its feet" and brake shoe friction keeps it "off its feet."

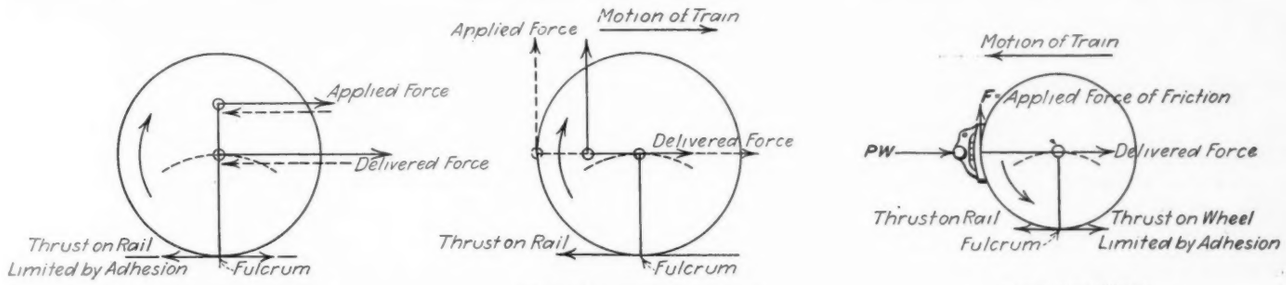


Diagram Showing Why Wheels Slide

However, even though the car is knocked off its feet and thus the wheels slide momentarily, it doesn't always follow that they will continue to slide. For if the pull of the rail with the wheel sliding exceeds the pull of the shoe, the wheel will commence to rotate again and so continue. This statement will help to nail the fallacy that once a wheel starts to slide it will *always* continue to slide; and, also, that a wheel can be slid from a standstill with a low cylinder pressure. To slide the wheel from a standstill, or to keep a car off its feet, once it has been knocked therefrom, either the cylinder pressure must be high or the rail bad, or both. The assumption made in the analysis appearing on Plate 2 is a cylinder pressure of 34 lb. and a drop in wheel-rail friction from 25 per cent to 10 per cent and a rise in shoe-wheel friction from 15 per cent to 30 per cent. With a loaded car the cylinder pressure will have to be *very* high and the rail *very* bad before the wheels can be slid from a standstill or will continue to slide after a shock has knocked the car off its feet. That is, slid flat wheels appear on empty cars much more frequently than on loaded. The cylinder pressure or rail condition necessary to keep wheels sliding on passenger cars is

*Abstracted from a paper on the Empty and Load Freight Brake presented at the February meeting of the St. Louis Railway Club by Walter V. Turner, assistant manager, Westinghouse Air Brake Company.

much less extreme in value, due to the use of a much higher braking ratio than on freight cars.

An impact opposed in direction to the motion of the train can effect the same result if it be enough greater, other things being equal, to neutralize the rail thrust set up by brake shoe friction and carry in the opposite direction beyond the limit of wheel adhesion. The wheel once stopped in rotation, be it but for an instant, is readily "locked" by the brake shoe as pointed out above, and it continues to slide, provided the brake shoe friction exceeds the wheel-rail friction.

For example: A freight car weighing 50,000 lb. has an adhesion of 3,125 lb. per pair of wheels, if the factor of adhesion is 25 per cent. A 15-lb. brake pipe reduction gives 690 lb. brake shoe friction for 60 per cent braking ratio on 50-lb. cylinder pressure, 85 per cent brake rigging efficiency and 15 per cent brake shoe friction. An impact of 200,000 lb. will bring the total rail thrust up to the above adhesion limitation. If the braking force is greater, the impact greater (not unusual in service), or the adhesion less, the car will be "knocked off its feet." If the brake shoe friction at this instant exceeds the wheel-rail friction the car will be held "off its feet." This will be true if the rail friction drops to 10 per cent (1,250 lb.) and the shoe friction rises to 30 per cent (1,380 lb.), due to the change from static to kinetic friction and vice versa, respectively. Under the same conditions an impact in the opposite direction must exceed 300,000 lb. to knock the car off its feet. The impact computation is based on two 700-lb. wheels and a 500-lb. axle having a moment of inertia of 143.

Thus it is obvious how prolific in slid flat wheels may be shocks due to the lack of uniformity in braking.

SYSTEMATIC REPAIRS TO FREIGHT EQUIPMENT

BY F. G. LISTER
Mechanical Engineer, El Paso & Southwestern, El Paso, Texas

On a railroad system where it is the practice to make extensive repairs to a series of freight cars of the same kind, or where a large number of new cars of one type are being built, a systematic arrangement of the work is of the utmost importance in order to keep costs as low as possible and not keep the cars out of service any longer than is absolutely necessary.

The El Paso & Southwestern system has arranged an organization at the El Paso shops which it is believed brings the cost of repairs down to the minimum. The organization consists of a number of gangs of men, each gang having a special line of work to perform in a given length of time. The number of men in each gang depends altogether on the class of work to be done. An example of this organization is outlined below for a series of 50-ton box cars which were recently put through the shops and rebuilt. The required output was one car every five hours with a gang of 27 men, and the number of gangs, and men in each gang, were arranged accordingly. This, of course, means that each gang must perform its particular work on each car in the five hours.

Gang No. 1.—Remove trucks and apply temporary trucks. Send trucks to truck repair track or shop for required repairs. Strip car of all appliances that are to be removed.

Gang No. 2.—Remove tie rods, broken or decayed posts, and other defective parts. Clean out all post pockets.

Gang No. 3.—Repair steel underframe.

Gang No. 4.—Apply posts, side and end plates, belt rails, cripples, ridge poles, carlines, grain strips, side sill nailing strips, decking, tie rods, and square up car.

Gang No. 5.—Apply all lining, siding and roof sheathing. Apply side and end door tracks, guides, stops, threshold plates, etc.

Gang No. 6.—Make or repair side and end doors, latitudinal running boards, etc.

Gang No. 7.—Apply roof, fascia, running boards, and safety appliances, hang side and end doors, apply brake staffs and foot boards.

Gang No. 8.—Repair trucks and apply them at this point in the line. Repair draft gear.

Gang No. 9.—Apply first coat of paint (eight hours to dry); apply second coat of paint (eight hours to dry).

Gang No. 10.—Stencil. Car O.K.

In organizing a gang for making repairs as outlined above, there must first be ascertained the required output of O.K. cars per day, then a unit of work or schedule of operation established, each operation of which must be completed in a stated time. If it is desired to turn out a car every 30 min., the operation must be manned sufficiently, and the operations must be what every man or gang of men can do in that time. A 30 min. schedule on a steel underframe box car similar to the above series of cars would require about 80 men, and from 16 to 20 operations, on which would show a labor cost of about $12.00 per car if the average wage does not exceed 30 cents per hour. Of course, mill labor would be a separate item, as there are very few mills capable of handling material this fast. Therefore, material for the entire output of cars must be accumulated in advance.

The man assigned to the work of organizing the gangs for this work must have a thorough knowledge of what a man or gang of men is capable of doing in a given length of time. Upon this hinges the success or failure of the plan. At the end of each 30 min., or whatever period is decided upon for each operation, each gang moves each car ahead one car length, which will turn out a car O.K. every 30 min. It is imperative that the entire line move promptly at the end of the required period of time.

Just before the car goes to the painter, two or three men, known as the "OK" gang, go over the car and finish anything that may have been left uncompleted by some one of the other gangs at the expiration of their work period. By watching at this point for uncompleted work the incompetent workmen can be traced and weeded out, as every man does the same work on every car handled. Anything he leaves undone shows up when the inspector goes over the finished car.

By specializing the work in this way each man in a very short time becomes an expert in his particular operation, and it is surprising how each gang watches the gang ahead and behind to see that they are not through first. Of course, if one gang stops or lags, the entire line will be held up. But if the man in charge is alert and keeps in close touch with his gangs and what they are doing, he will see to it that not a single operation fails after the first eight or ten cars are put through.

In order that work on the roof and upper part of the body may move rapidly, a scaffold should be built on each side of the repair track the length of the line. It is necessary that a sufficient number of cars be on hand and that they be lined up on a track open at each end. Sufficient material should be gotten out before the cars begin to move so that there will be no possible chance of the gangs being held up. For the second coat of paint and stenciling, the cars may be moved to a separate track.

After the work is started and is in full swing, a piece work price would be placed on each operation, and will give the men performing the operation, each a fair day's wages. This price, when it has once been established, makes the cost per car, under all conditions, the same for every car that is turned out.

SHOP PRACTICE

INTERESTING BOILER SHOP DEVICES

The following four devices in use in the boiler shop of the Elgin, Joliet & Eastern at Joliet, Ill., have been found useful in making repairs to locomotive boilers. Fig. 1 shows

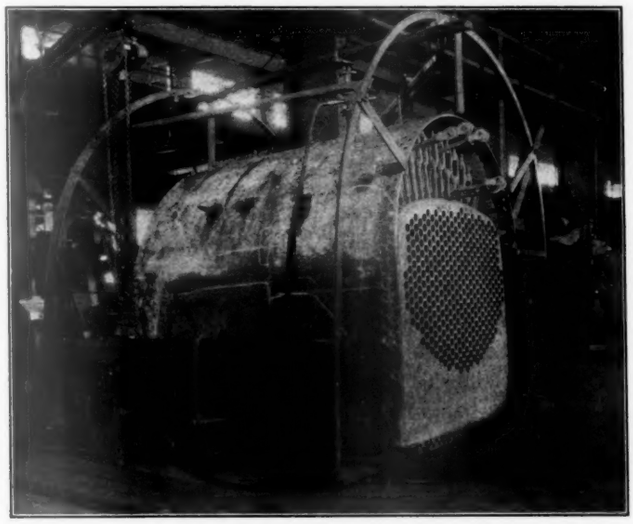


Fig. 1—Jig for Drilling Holes in Firebox Wrapper Sheets

a frame surrounding a firebox for the purpose of backing up air drills, reamers and the like, used in drilling the wrapper sheets. It consists of a frame work of angle iron bent

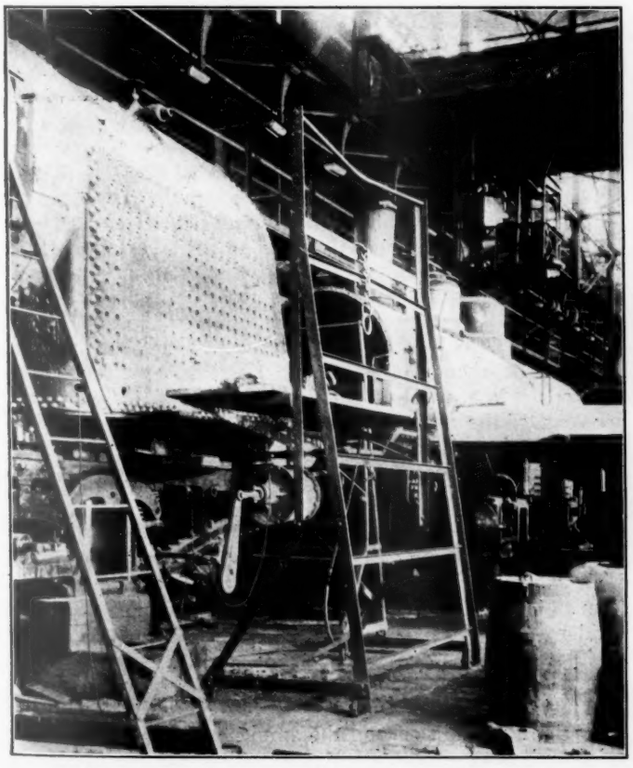


Fig. 2—Portable Scaffold for Boiler Work

to conform to the shape of the firebox, supported by tie bars extending out from the boiler, as indicated in the illustration. The two angle forms are tied together by heavy planks

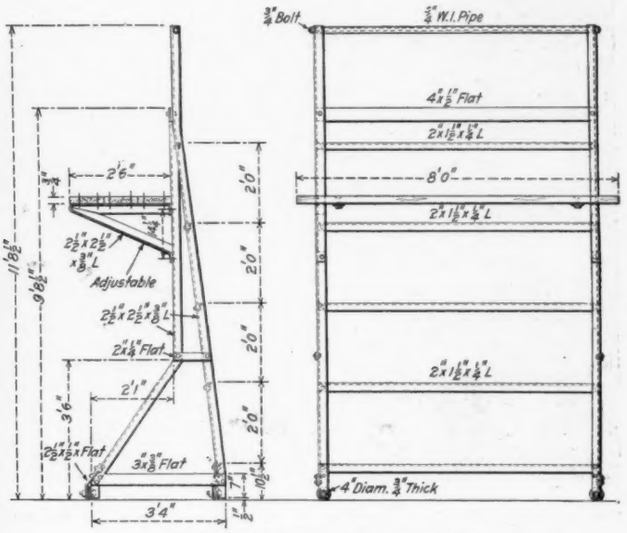


Fig. 3—Portable Scaffold for Boiler Work

which are adjustable on the bars and serve as back rests for the air motor.

Figs. 2 and 3 show a portable scaffold for use in working on the boilers. As indicated in the sketch, it is made up of angle iron and supported on small wheels so that it can be easily shifted from one part of the engine to the other. In moving it about the shop it is handled by the overhead crane. The scaffold may be adjusted to any height, bolt

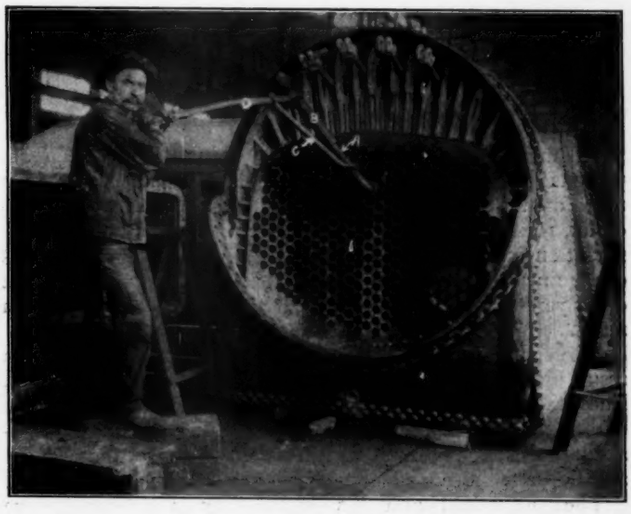


Fig. 4—Holder-On for Riveting the Boiler Barrel to the Wrapper Sheet

holes being provided in one leg of the vertical angles for securing it to the frame work. At the top there is a rail between the two uprights, which prevents the men from falling when the platform is raised to the top of the scaffold.

Fig. 3 shows the method used for backing up the rivet

hammers when riveting the boiler barrel to the firebox, the helper, of course, being inside the barrel instead of on the floor, as indicated in the illustration. This device consists of a rod *A*, which is bent and threaded for a nut at the tube-sheet end in order to hold it in the tube sheet. The anvil is mounted on the tubing *B*, which slides on the rod *A*. The truss rod *C* is hinged to both the rod *A* and the lever *D*, and forms the fulcrum for the lever. The weight of a helper on

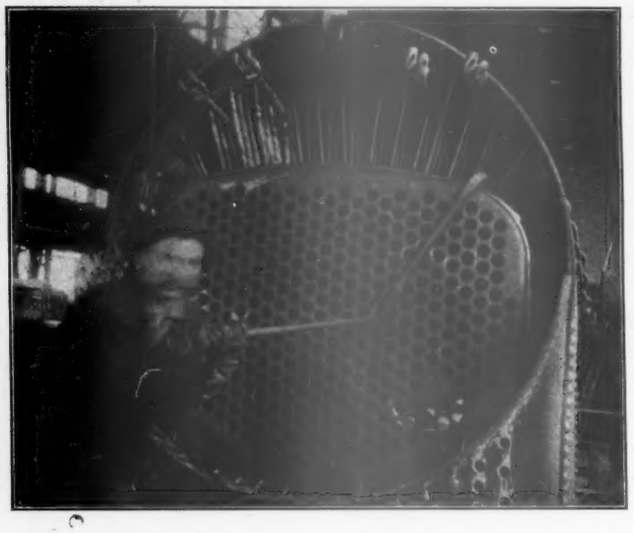


Fig. 5—Holder-On for Riveting Tube Sheets to the Crown and Side Sheets

the end of the lever arm *D* forces the anvil out against the sheet, providing a substantial backup for the riveter.

Fig. 5 shows a similar device for riveting tube sheets into the firebox sheet. In this case, as before, the helper is on the inside of the boiler and putting his weight on the lever brings the anvil hard down on the crown sheet. The end of the anvil rod is equipped with a turn buckle so its length may be readily adjusted. The other end of the lever arm is simply placed in one of the holes in the tube sheet.

EFFICIENCY IN SCHEMING

BY RUSSELL R. CLARKE
Assistant Foreman, Brass Foundry, Pennsylvania Lines, Pittsburgh, Pa.

All industrial service improves with quality and congenial personality of workmen, suggesting the advantage of a plan to differentiate in choosing men. Manners, intelligence, principles, record and experience can be drawn out by casual conversation in sizing up the applicant. A record of constant change means something, while a man willing to belittle past employers will usually be found hiding behind a question mark.

Interesting workmen is vitally important, co-operation resulting. Men like to co-operate on a participating basis. Encouragement inspires suggestiveness in men and intensifies effort. Often we have thought of something and in a round-about way solicited opinion. From many suggestions we got a little better idea and gained co-operation in advancing it.

The individual and his inclinations is a remunerative study. Failure in one capacity is no absolute evidence of his worthlessness. Every good man has his element. The problem is to discover this and place him in the proper place.

Square dealing, preparedness and precision in plan and execution are essential to best results in introducing an idea. A scheme once launched will often capsize at a single break in piloting it.

Men love and trust the open plan. Improvements were made on a car bearing boring mill to increase its output by nearly one-half, and a test made. Nothing was concealed, the regular operator being told to get out 500 bearings as quick as honest effort could accomplish it. We figured on nine hours; he did it in seven hours forty-two minutes.

All classes of men have leaders. In scheming it pays to reckon with them. We once changed our machine molding system, encountering stiff opposition from the men. We got in touch with a leader, offered him inducements to give the thing an honest trial and we would abide by the results. He accepted, and the system worked to the ultimate satisfaction of all.

In all departments waste of material and abuse of equipment demand consideration. To overcome this waste we have disciplined and fined more or less effectively. Greater than all, however, we attempt to educate workmen to a keen sense of moral obligation. To the guilty man we now present a serious analysis of his conduct and inquire what he would do if he were in authority.

Progress on work passing through different channels to completion merits attention. We find it a good plan to draw sharp lines of related responsibility and hold each man strictly accountable for conditions in his field.

Cultivating a spirit of helpfulness with other department heads is a broad idea. We invariably aim to accommodate.

Teaching men to work from motive instead of precedent develops efficiency. The automaton is the zero of accomplishment. We scheme to better things by taxing individual resources and withdrawing temporary aid.

Little meeds of praise count much. Each task faithfully performed, every added year of good service, merits recognition. To accord such spurs men to stronger effort.

In discussing plans or issuing instructions we find the plural "we," a much better pronoun than the singular and exclusive "I."

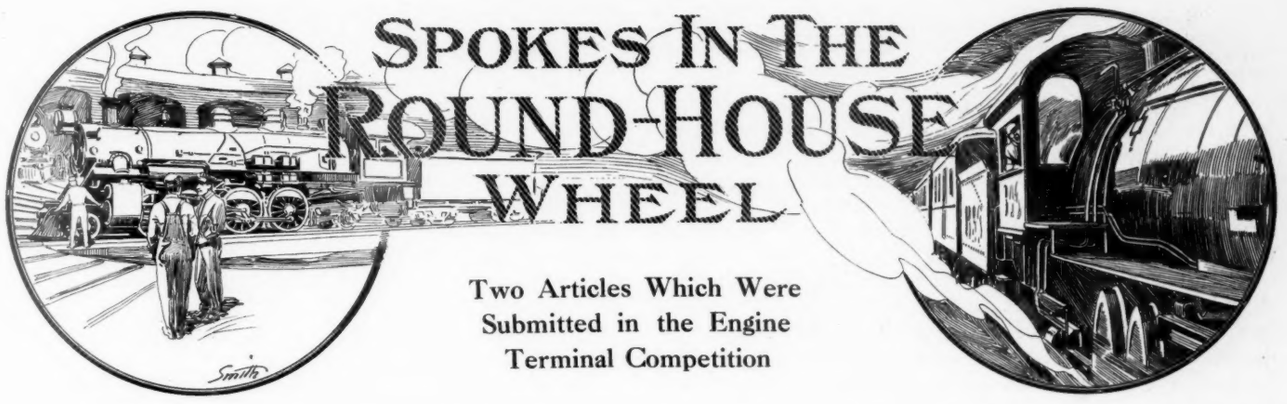
New and added equipment offers splendid opportunities. We always encourage men to study machines and equipment, discover shortcomings and suggest improvements.

Encouraging men to familiarize themselves with details of work outside their own prescribed effort, though related to it, is often beneficial. We find this admirably applicable in foundry casting inspection where familiarity with the principles of molding is a great aid to high-class inspection. Actual demonstration of a machine's reasonable capacity will often work in spurring indifferent workmen to put forth more effort. Sometimes we put a hustler on a job just to show some indifferent man what the possibilities of the job really are.

Shop order and cleanliness are important. We remember a dark corner and a bad machine where nobody worked with heart. We cleaned the place up, added new lighting facilities and repaired the machine. The dark corner and poor machine jumped above par at once.

Russian Coal.—Russia's production of coal during 1913 amounted to about 31,000,000 tons, and in 1914 to 28,000,000 tons. As the Polish districts, which in 1913 yielded 22 per cent. of the aggregate output, are now occupied by Germany and Austria-Hungary, Russia's production of coal for 1915 cannot be estimated at more than 20,000,000 tons.—*Engineering.*

Safety of Closed Feed-Water Heaters.—Closed feed-water heaters become weakened from the corrosive action of feed waters, and serious injuries by scalding have resulted from the unexpected rupture of the shells. To guard against accidents, the shell of a closed heater should be frequently subjected to a test pressure not less than 50 per cent greater than the highest pressure possible for the discharge from the feed pump. Trials of the safety valve should also be made to determine its condition and the ampleness of its capacity for safely relieving excessive pressure when the feed pump is operating at its maximum.—*Power.*



SPOKES IN THE ROUND-HOUSE WHEEL

Two Articles Which Were Submitted in the Engine Terminal Competition

HANDLING A BIG ENGINE TERMINAL

BY PAUL A. SCHENCK

There are today more enginehouses which are having difficulty in meeting the service demanded of them, due to poor facilities than to poor organization or poor management. The size and number of locomotives has increased at a greater rate than have the facilities for handling them. In many cases, a recommendation from the enginehouse foreman might bring about needed improvements. In other cases he might help himself. Possibly he has a compressor which will not maintain a working pressure and although he has asked for a new one, his men have been kept so busy trying to drill out broken bolts and bead tubes with 50 lb. air pressure, that he has not had time, or rather has not taken time, to overhaul the compressor and repair the leaky pipe lines. It may be that he has done everything in his power, but his superior officers have been too busy putting new rail on the main line to put in a new outbound track at the engine house or a new motor on the turntable.

It is deplorable to see the struggles that are made to meet the service of today with the enginehouse and terminal of 15 years ago. The ties and rails have been replaced, the locomotives have grown in size and power, the cars are bigger, the yards have grown, the freight houses have grown; in fact everything has outgrown a large percentage of the enginehouses in service today.

For efficient work, the tracks from the yard or station to the enginehouse should be so arranged that an engine which has but a short time from its arrival to leaving time does not have to spend two out of the three hours in going and coming from the station to the enginehouse. The inbound as well as the outbound tracks should pass the coal chute, and the chute should be of a capacity large enough so that coal will be always waiting for the engines instead of the engines waiting for the coal. The same may be said of the water service.

Some ashpits are so designed that it is impossible for one engine to pass another at this point and delays occur accordingly. With an ashpit so arranged that one engine can be run around those already on the pit, it is an easy matter to give a "short turn" when desired. Where there are perhaps three engines having their fires cleaned and two behind them awaiting their turn, and but one track over the ashpit, it takes time to have the fire cleaned on an engine coming in for a quick turn, and it is hard to explain to the despatcher why it has taken an hour and a half to clean the fire and turn an engine on the turntable.

Next comes the turntable, or "king pin" of the engine terminal. When the turntable stops, the entire plant stops. Is the best any too good for this important factor? In order to despatch 100 engines a day, the table must turn two hundred times in getting the engines in and out, 40 times more for other purposes such as "spotting" dead engines, putting in wheels, etc., making 240 times in every 24 hours, or an average of once every six minutes. If an electric motor is used to drive the table, an emergency engine of some description should be mounted and ready for service at the other end. No matter what power is used, for that matter, there should be something besides pushing by hand, to fall back on when it fails.

Before going into the house, let us look at the outbound, and storage tracks. Are there several tracks or but one track by which an engine may leave? Although all of them converge into but one outbound track passing the coal chute, there should be several between this point and the turntable, where outbound engines may be lined up when they are ready for service and the room which they occupy in the house is needed for other engines, or when there are so many due to leave about the same time of day that it is impossible to handle them all over the turntable without a delay to some. A sufficient number of storage tracks to accommodate all extra engines, engines awaiting material, stored engines, extra wheels, etc., are indispensable. In many cases, the capacity of an enginehouse may be easily increased by the addition of storage tracks. There is no need of taking up valuable room in the house, with engines which are apt to lie for any length of time.

If the enginehouse is located in a climate of severe winters, it should be long enough so that the doors can be closed behind the engines in the house if effective results are expected from the workmen. No matter what the heating facilities are, no house can be kept warm if the doors are open and a cold house is an inefficient house. How can a man keep his mind on his work if he is having a struggle to keep warm?

Drop pits should be furnished, which are suitable for all wheels. If tank and engine truck wheels can be renewed in an hour by using a drop pit, where it would take four hours without, not much figuring is needed to indicate the saving thus affected.

The better the power plant and machine shop, the more efficient will be the enginehouse. The old idea that any machine, boiler or compressor which has been worn out in the shop should be put up in an enginehouse instead of being scrapped, is fortunately dying out. As a rule a shop is better able to get along with a machine which is on its "last legs" than is an enginehouse. The machines may not be used steadily from morning till night, but an important train may be delayed on account of a lathe breaking down while boring a set of piston packing or a drilling machine failing while drilling a crosshead shoe.

The storeroom is a hard proposition at the best and one which requires the closest kind of co-operation between the enginehouse foreman and the storekeeper; but in far too many cases the former expects the latter to be somewhat of a mindreader in regard to material needed. If he would spend more time in going over the stock with his storekeeper and

weeding out the surpluses, the latter could order more of the essentials without fear of being reprimanded for carrying too large a stock.

The best organization is the one which can turn an engine in the shortest time without overlooking any work. A large blackboard will be of great benefit to any enginehouse in recording the progress of work. The size of the board in regard to length depends upon the number of engines handled and the items may vary to suit local conditions. A separate board for each division using the terminal will be found convenient.

A man who has had experience enough to be a foreman should know about how much work a man can do in a day or a certain time without watching him, and can put all of the work slips on certain kinds of work into a box where the workmen can get them. A box of this kind located near the black board will save many steps both for the foreman and the men.

The greater the responsibility felt by the men, the less supervision is necessary and the less the foreman will have to carry; and the more time he will have to investigate and improve the general conditions of the enginehouse. If this responsibility is not already felt, it can easily be brought about little by little until the pipe fitter will take so much pride in the condition of his pipes that he will tighten a check pipe which he sees leaking without waiting to be told, and do many other little jobs which take but little of his time when done in this way. On the other hand, were the leak unnoticed until the engineman had found it after backing out of the house, he would have to hunt up the foreman, who, in turn, would have to find the pipe fitter, stop the work which he was doing and by the time the leak was repaired, the engine would be badly delayed. Moreover, the foreman would have lost his time and his temper, and the pipe fitter would be disconcerted for an hour. The same can be said of the work of the air brake inspector, the cab man, and, in fact, all work which is specialized and looked after by one man or gang of men.

Some difficulty may be found in locating the inspector, or whoever is wanted, without considerable hunting. This is overcome by the flag system, under which each specialist carries a flag or lantern of distinctive color and when he goes to work on an engine, places it on the pilot. This system is used on several roads with good results.

One of the hardest problems is keeping the house clean and the space between the pits clear of obstructions. If the floor is once cleaned up and each individual given to understand that they must pick up all tools, scrap, and material of all kinds when they complete a job, the floor can be kept clean.

With proper facilities and organization, the efficiency of an enginehouse should increase with the size of the house up to the limit of the turntable, for the larger the terminal, the greater is the opportunity for installing systematic and efficient organization, where someone is responsible for every move and each part of the locomotive, from the time of arrival until it leaves on its outbound trip. Any hitch in the work while the locomotive is at the terminal, or the failure of any part while it is on the road, can then be easily traced to the individual responsible.

SOME NOTES ON ENGINE TERMINALS

BY GEORGE TWIST

Locomotive Foreman, Canadian Pacific, Fort William, Ont.

In considering the management of an engine terminal we must commence with the general foreman. He should be intelligent, courteous, farseeing and above all, ambitious and enthusiastic. Without ambition and enthusiasm he cannot be successful as undoubtedly he will be subject at times to criticism which would knock the spirit out of a man without these qualities. He must gather around him a staff of foremen, any one of whom would be able and willing to handle the station successfully in his absence. His staff should be so organized that every man's work, no matter how seemingly unimportant, may be checked up and the responsibility placed for failure.

Shop tracks should be so laid out that the possibility of a tie-up through accident will be reduced to a minimum. Crossovers should be suitably placed to enable an engine to be taken out of a line of power when required for quick turn around or to go into the shop. It frequently happens that engines are required for special service, or for work that men are waiting to perform and it necessitates a lot of unnecessary switching to get an engine into the shop at such times. Shop trackage laid out with convenient crossovers will avoid such extra work and consequent delays.

Suitable lockers should be provided in a clean room to permit of the men keeping their clothes clean and comfortable. In too many roundhouses there are used open steelwork lockers through which the steam, water, and smoke can pass and come in contact with the clothing. All shops should be kept clean and comfortable in order to obtain the best results from the workmen.

Hostlers should be assigned to special work where the output of terminal is sufficient. For instance, the work of turning in should be handled by a different hostler or hostlers from that of turning out. Hostlers taking charge of engines on arrival should inspect the firebox and see that the leaks are promptly reported. Many cases have occurred where the responsibility for damaged boilers due to low water has not been properly placed because of not inspecting engines on arrival.

When taking coal care should be taken not to overload tender, and the coal should be trimmed so as to avoid waste through allowing it to fall on the right of way. When an engine is standing over the ashpit, the air pump should be shut off in order to avoid the possibility of dust being drawn into the pump and causing unnecessary wear. In knocking out and cleaning fires, water should be used freely in the ashpan and pit to keep down the dust. The blower should not be used too strongly when cleaning or knocking out fires as this is frequently the cause of tubes and staybolts leaking. In moving engines around shop tracks, care should be taken to see that all switches, derails, etc., are set correctly, and engines should not be moved too fast. Considerable delay might occur through carelessness or negligence in this. If engines are pooled, all tools, etc., should be taken off by a man assigned to this work and put away in the place provided for this purpose. Hostlers should see that no tools or equipment are left unprotected.

When an engine arrives in the shop, no time should be lost by the different foremen in getting their men to work in order that no unnecessary delay will occur in getting power back into service. The men assigned to the work should be chosen only because of their qualifications. Roundhouse work is often looked upon as rough and not very particular. This is a wrong viewpoint; every job should be done properly. If at any time due to lack of time or of material a thoroughly perfect job cannot be made the foreman should decide what means to adopt. No workman should be allowed to put up a makeshift job on his own responsibility as this tends to encourage and cultivate the habit of letting work go improperly done. Foremen should be kept informed of the special or heavy work required, and a bulletin board marked up for the information of hostlers and others, so that engines may be placed in a part of the shop set aside for special work.

Every man should be instructed in his special duties and should be disciplined for neglect. Care should be taken by boilerwashers to avoid scale and grit being allowed to get into the machinery, and good canvas coverings should be provided. Foremen should check up the work being done

and men who are not giving value for the money they are getting should be cautioned and assisted to improve; if after a reasonable time they do not show improvement, they should be replaced. Boiler foremen should go into fireboxes on every possible occasion and check up the tube cleaners, as this is a job which is frequently improperly done, men often cleaning the tubes only a short way in. Boilermakers and tubers should be taught the proper use of the beading tool as it has been found that the improper use of this tool is accountable for much trouble from tube leakage. Tools should be abundant and kept in good order.

A close check should be kept on work reports, and jobs which are booked to be done and O. K.'d by mechanics, and are later reported again should be examined personally by the shop foreman, in order that steps can be taken to prevent engine failures which frequently occur through work being improperly done. It often happens that an engine comes in trip after trip requiring new piston rod packing. Investigation will probably reveal the fact that the crosshead is very slack in the guides, the piston too small for the cylinder or that the rod is bent or scored. Each time work is improperly done means loss of time and money. When an engine is O. K.'d and is ordered out on the road care should be taken to see that the crew is around in time and that nothing is allowed to prevent its leaving in ample time, fully prepared in every way to make a successful trip. Regarding terminal delay and engine failures, if every man understands his duties and performs them properly, and foremen and engine despatchers insist on engines being O. K. before supplying them, the delays will be few. There are engine failures that are sometimes unavoidable, but experience has shown conclusively that a large majority are man failures and could be avoided. Pick out the proper men to inspect and repair the power, lay down instructions and see they are lived up to, take no unnecessary chances, and the engine failures will be reduced to a great extent. In conclusion, just a word about organization. No foreman has his shop properly organized unless it is possible for any man to be away from his duties and still have his work go along smoothly. This applies particularly to the foreman himself. The most perfect organization is the one which allows the foreman to be the least missed of any man.

CLEAN LIGHTING FIXTURES

There is nothing on a railroad that depreciates so rapidly as does the efficiency of the lighting system. The rapid collection of dust and smoke on the lighting fixtures causes the illumination to be reduced to about 50 per cent. of its initial value in some locations within a week, and in the average station or shop it would reduce to about 50 per cent. efficiency in one month.

The saving effected by systematically cleaning reflectors and lamp bulbs will more than pay for the small extra expense involved. The following example will serve to emphasize this point. Take a railroad which operates 5,000 150-watt lamps and assume that these lamps burn eight hours out of every 24 and that the cost for current is two cents per kw. hour. The total cost of current per year then will be $37,560. It has been shown in numerous tests that a collection of dust and soot on reflectors and lamp bulbs will reduce the illumination by 50 per cent. This means that if the 5,000 reflectors and bulbs above mentioned are not cleaned half of the light from these lamps will be absorbed and wasted, causing a direct loss of $18,780 per year, while on the other hand this amount will be saved if the reflectors and bulbs are systematically and regularly cleaned. The cost of cleaning will not amount to more than three cents a fixture a month or a total of $1,800 a year, which is only 9.6 per cent. of the saving. In other words 1,040 per cent. will be earned by the investment.

In addition to the saving in energy thus effected will be the saving in workmen's time which would be lost due to inadequate illumination if the reflectors and bulbs are not cleaned. Ordinarily the expenditure for lighting is about ½ of 1 per cent. of the wages of the workmen employed, while to properly maintain that lighting system costs only about 1/30 of 1 per cent. of the wages.—*Railway Electrical Engineer.*

FORGE SHOP PRACTICE

BY V. T. KROPIDLOWSKI

There is often considerable choice of method in forging, and the skillful workman selects that method of procedure which will produce the results with the least amount of manual labor. The practices in blacksmith shop work herein illustrated were described to the writer by an expert in smith shop work. Fig. 1 shows the method of forging a cage for a spherical valve of a deep well pump. First, hammer out a round disc to the required thickness and diameter,

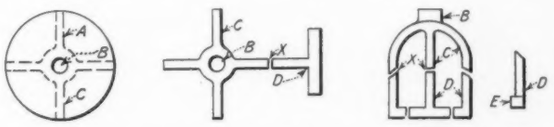


Fig. 1—Forged Cage for Spherical Pump Valve

leaving a boss *B*, into which is to be screwed the pump rod; then cut out the solid segments *A*, leaving the portions shown in dotted lines. The segments cut out make four tee-shaped pieces *D*, of the required dimensions, the Tee being thicker than the "stem," so that thread can be cut when the cage is finished on the inside, *E*, for a brass seat to be screwed

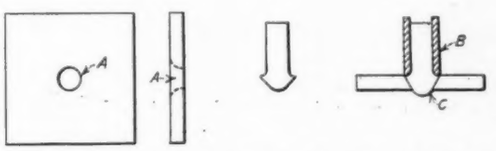


Fig. 2—Forging an Expansion Plate with a Gudgeon

in. Having made the Tees, they must be welded to the other piece at *X*. The whole is then shaped over a mandrel. The bronze cages usually break in a short time, due to crystalizing of the metal, but wrought iron cages made 13 years ago are still in service.

Fig. 2 illustrates the forging of an expansion plate with a gudgeon. Cut off a square piece from a flat bar, punch a

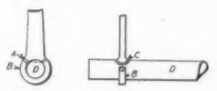


Fig. 3—Welding on a Tumbling Shaft Arm

hole *A* and scarf it as shown. Cut off a piece from a round bar and upset it at one end as shown. Set the upset end in the hole *A* and use a tool *B* in making the weld. Strike a few blows on *C* and the expansion plate is made.

In welding an arm at right angles to a round bar in making a tumbling shaft, Fig. 3, take a piece of 1-in. square iron, *B*, and weld it around the round bar *D*. Hammer out the arm and upset it to form the required end; fuller out the round bar as shown at *C*, and set the arm in the fullered place in the bar *D*. Strike with a hammer on the fillets of the arm and also on the ring *B*, to weld it to the arm at *A*.

Fig. 4 shows the forging of rod straps. Hammer out a

bar of rectangular section to the required width and the thickness wanted at the end of the rod; or if the boss to form the grease cup needs to be thicker than the end, make it of that thickness, fuller it out as shown and draw down

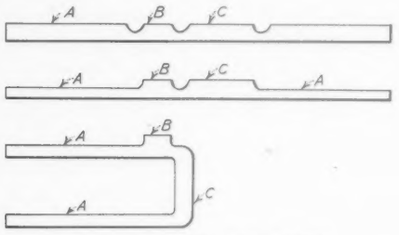


Fig. 4—Forging Rod Straps

the ends *A*, leaving *B* and *C* the same thickness. Bend it to shape as shown.

Fig. 5 illustrates a method of forging valve yokes. There are several ways of making a valve yoke, some probably

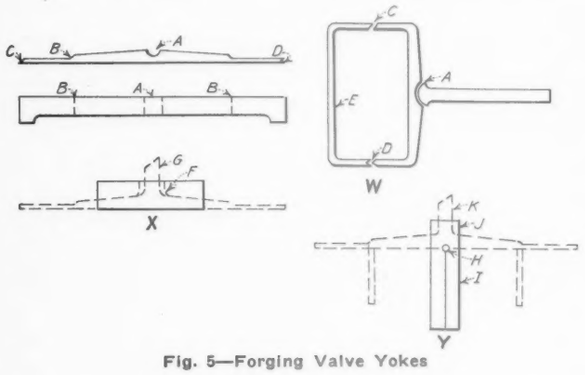


Fig. 5—Forging Valve Yokes

quicker than this, but they do not result in as good and durable yokes. One method is shown in *X*. Take a piece as shown by the full lines and hammer it out to the dotted line shape, leaving a boss which is then hammered to the

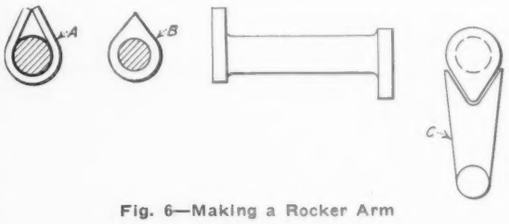


Fig. 6—Making a Rocker Arm

shape *C*, when the stem can be welded to the scarf. This method has the objection of the stub *G* being cross-grained, and invariably it will break. Another quick method, which usually is the most common practice, is shown in *Y*. Take a piece as shown by the solid lines, punch a hole *H* and

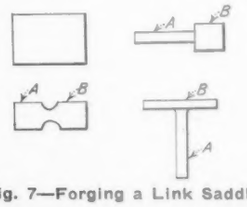


Fig. 7—Forging a Link Saddle

split the piece along the line *I;* spread it and hammer it out and bend as shown by the dotted lines; then draw out the boss *J* to the shape *K* and weld the valve stem to the scarf. This has the same objection as the first one, the metal being cross-grained. The best method to obtain a strong job is as follows: Hammer out a shape as in *W*, and fuller out at *A*. Hammer out another piece *E* and weld to the front piece (after both are bent) at *C* and *D;* either a scarf can be used, as at *C*, or the method shown at *D*, the latter being recommended. Now hammer out a round bar, upset it, and weld it into the fullered space, as at *A*.

Fig. 6 shows the making of rocker arms. Take a piece *A* of square section and the required dimensions and weld it around a round bar at the end; repeat at the other end as shown. Now hammer out two arms *C*, the required size and shape, U them in and weld to the ends as shown.

Fig. 7 illustrates the forging of a link saddle. Take a rectangular piece like that shown, of the required dimension. Fuller it out on both flat sides, then draw out the end *A* round. Flatten out the end *B* to the required dimensions.

PISTON VALVE PACKING RINGS

BY JOHN V. LeCOMPTE

The piston valve is much better than the slide valve for locomotives; it is more equally balanced and has low cost of upkeep. The built-up type piston valve, composed of one spool, two bull rings, four packing rings and two follower heads, which clamp the valve rigidly in position and form walls for the two end rings, gives the greatest satisfaction. To obtain the best results from this valve the bull rings should have a limit of wear not to exceed 3-16 in., so as to provide a bearing surface of the packing ring on the bull ring great enough to hold the ring in its proper position. The same is true of the follower heads. The end play of the packing ring should not exceed the thickness of a piece of paper, and should be just enough to permit the packing ring to work freely.

The wearing surfaces of a valve should be made of the best material possible to insure long life to the valve, a good mileage and low cost of repairs. This is especially true of the packing rings. The rings should not only be made of a good quality of iron, but they should be carefully turned and applied to the piston valve chamber in order that they will satisfactorily do the work required of them. The rings should be turned on a machine having two heads, both heads being used at once. They should be turned ⅛ in. larger than the bore of the valve chamber bushings, and, after they have been properly cut, they should be clamped snugly together on the face of a lathe or any other machine suitable for this purpose, and turned to the exact diameter of the bushings. This insures a snug fit of the rings in the bushings, and also at the break in the rings. After the rings have been made they should be handled with care, as careless handling in assembling, or applying them to the valve chamber, has often destroyed the efficient work done in their manufacture.

The valve chamber bushing should be maintained round and should be bored if it is 1-16 in. or more out of round. The cylinder casting itself should be properly bored, for otherwise new bushings, that are accurately bored, will be distorted when forced into the cylinder casting, which will necessitate reboring the bushings after they have been applied. If the rings are properly made and properly applied to perfectly round bushings, the oil consumption will be reduced, better mileage will be obtained, and there will be a reduction in repair costs.

PLACING U-BENDS IN PIPE LINES.—The bend should be in the same plane as the pipe; that is, it should be so placed that the ends will be forced nearer together or drawn apart by the action of expansion or contraction of the line whose variation in length it is intended to compensate by the flexibility of the bend.—*Power.*

WHAT THE BOYS THINK OF APPRENTICESHIP

Half-a-Dozen Letters From Live Apprentices With Suggestions as to Improved Practices

The two prize articles in the recent apprentice competition, together with three other letters, were published in our April issue, page 197. The following letters were received in this same competition:

AN APPRENTICE SCHOOL IS NECESSARY

BY WILLIAM HEISE
Machinist Apprentice, Erie Railroad, Jersey City, N. J.

I don't think anything quite equals a well-equipped, well-regulated apprentice school, with a capable, intelligent instructor, for aiding the apprentice. Those boys who already have a good knowledge of mathematics and drawing can go ahead with other more advanced studies. A little theory in the school room will aid them considerably in their shop practice.

A machinist apprentice should learn all about the various machines he is taught to operate. When he is working on locomotives the same thing should apply. The instructor would do well to give the boys lectures from time to time on lubricators, pumps, injectors, superheaters and the like. A few models for valve setting and shoe and wedge setting would not be amiss in the school room. Charts could also be hung around the school room walls with such important data as the various cutting speeds and feeds, and the proper way to grind cutting tools and drills. In fact, anything at all important pertaining to the machinist trade should be brought to the attention of the apprentice.

The boilermaker apprentices also have much to learn regarding their trade, which can only be taught in the school room. It is well enough to know how to do a certain thing, but it is also important to know why it should be done in that particular way. The boilermaker's apprentice should learn where to apply single or double rows of rivets, and the strains which rivets and staybolts must withstand. There is just as large a field of study for the young boilermaker as there is for the machinist.

The blacksmith apprentice has a somewhat different and more difficult proposition to deal with. There are, of course, many books written on the heat treatment of steel, forging, tempering, etc.

I think that it is up to all machine and repair shops of any considerable size to establish an apprentice school, if they have not already done so.

DON'T SCOLD

BY ARTHUR J. MERRIMAN
Boilermaker Apprentice, Atchison, Topeka & Santa Fe, Richmond, California

During my career as an apprentice I have found that the more a foreman encourages an apprentice the more willing he is to work and strive harder to succeed. One word of encouragement is worth more than all the scolding. Some foremen, of course I am not saying all, are in the habit of getting very angry when an apprentice makes a mistake. He is bound to make mistakes; if he did not, he would not be an apprentice.

After an apprentice finishes his course he does not want to get it into his head that he is through with his schooling. He is just beginning, and it is going to take a great deal of study on the outside to make of himself a capable and efficient mechanic.

I do not know if all railroads have established apprentice schools, but if other roads are working under the same system as the Santa Fe I cannot see how to make the apprentice course of greater practical value.

In the shops where I am working I have noticed a great deal of improvement in the last four years. The work is done now with more science and a great deal quicker. This road makes a practice of promoting its own men to fill vacancies as they occur, which I think is very good.

TEAMWORK BETWEEN SCHOOL AND SHOP

BY WILLIAM L. LENTZ
Machinist Apprentice, New York Central, Avis, Pa.

The apprentice school not only educates us for better and higher positions at the expiration of our apprenticeship, but makes it possible to attain more than a common school education. Then, too, the elements of that which inspire and make it possible for an apprentice to develop in knowledge may be found in the methods employed and advantages which these schools afford. This is not only true in regard to the four hours each week in the school room, but also of the confidence and tests of proficiency by the management during the regular working hours. The privilege of putting to a test the question or questions that arise, and which cannot be thoroughly solved in the school room, appeals greatly to the average apprentice. Furthermore, I am strongly impressed with the trust bestowed by the officers permitting us to perform special duty whenever it is necessary.

A greater interest would be taken in each apprentice school if a reward were given for the amount of work accomplished. Such a reward may be effected by awarding a bonus for all sheets of home or classroom problems, or other courses over the number required of each apprentice every month. This bonus may be any one of a number of articles, one of which may be a portion of a series of books similar to the Mechanic's Hand Book.

During the past two years of my apprenticeship I have visited three different railway shops in which apprentice schools were established, and have found the greatest mistake to be that the average class instructor does not know the situation among foremen, mechanics and apprentices. While the latter are being taught up-to-date methods of doing work by the class instructor, their superiors throughout the shop are teaching them methods many years behind the times. This has a tendency to keep both the school and shop efficiency down.

Many of the shop instructors become discouraged when instructing a boy who may be deficient in understanding. To overcome such a condition he should overlook these shortcomings and assist him in every possible way, instead of neglecting him entirely. Negligence and partiality on the part of instructors make all these deficiences possible, and may create in the mind of the apprentice boy the impression, "I am not getting a show."

THE RIGHT AGE TO START IS 18

BY NIELSEN POLLARD
Fourth Year Apprentice, Atchison, Topeka & Santa Fe, Albuquerque, New Mex.

The greatest factor in producing expert workmen from the average apprentice is the instructor, and by instructor I mean anyone who may have occasion to show an apprentice anything pertaining to his trade. Thus the need of having a good, clean and competent working force in clean and sanitary surroundings may be seen. These are first requirements

without which it is useless to try to produce expert mechanics. Also to produce efficient workmen the shop itself must be efficient with good, up-to-date machinery.

The instructor must be a man that apprentices can respect. If he is interested in their sports and can join in with them he can gain their confidence much more quickly. It is also a great advantage for an instructor to have served his time as an apprentice, for in no other way can he understand the apprentice's private opinion of his job.

The apprentice believes he is there to learn his trade, not to see how many pieces of work he can turn out in a day. This is why I do not believe in a bonus system for apprentices. One must first learn thoroughly to do a job correctly before he can speed up, and when he has learned to do a job correctly it is time to go to something else. At any rate, bonus will have very little effect on an apprentice who is interested in his work. A good apprentice will not slight any thing for bonus, and he will not be capable of turning out good work any faster than he is.

And last, but not by any means the least, and perhaps from the employer's standpoint it is the first, is the selection of the apprentice. I believe that the older the apprentice is when he starts the better he will be when he graduates. If he is 18 years old he will have outgrown his boyish tendencies toward having a good time during working hours and will settle down to a good, steady pace. Also if he is 18 he will have had time to go to high school, and the more general education a boy has the better it will be for all concerned. Also an apprentice of 18 will practically have attained his growth physically, and a good strong body certainly helps; at least it does in locomotive shops. I have seen apprentices with no great intelligence forge far ahead of the others simply on account of being strong and husky.

THE NEW APPRENTICESHIP

BY WM. JOHNSTON
Fifth Year Locomotive Apprentice, Canadian Pacific, Montreal, Canada

Hand in hand with the rapid increase in train tonnage, larger locomotives, heavier cars and extensive shops has risen the demand for more efficient mechanics to cope with the maintenance and operating conditions of the railroads of today. To this end the old apprenticeship system has had to give way to better.

The old system of rough and tumble, get through anyhow, of favoritism and its attendant discontent and discouragement to the less favored apprentices, has passed, and in its place has come a golden opportunity to the young mechanic, where systematized instruction in the modern theory and practice of the trades is given by expert instructors. Under the new system merit, grit and intelligence are the only factors that count; each apprentice has an equal chance to make good; his work is carefully inspected and criticized, advice being given towards improvement.

In conjunction with the practical shop work is the school work, the apprentices being paid the regular rates while in school, a thing unheard of a few years ago. Scholarships are offered annually, enabling the brightest apprentices to continue their studies into their future life's work, and many of the modern roads maintain a university scholarship for those of their apprentices who qualify, thus enabling an earnest, ambitious young apprentice to start right at the foot of the ladder and to climb right through to the uppermost rung of the profession by simply applying himself and grasping each opportunity offered by his apprentice course.

The social side of apprentice life has also expanded. Many lines now encourage and organize baseball, amateur athletic and debating clubs and inter-shop teams, and matches are regularly played, lending an altogether different aspect to the former humdrum existence of the apprentices.

More attention might be paid to attracting the young men graduating from the high schools, who at present largely drift into poorly paid office work, through ignorance of the splendid opportunities offered by the leading railroad apprentice courses and the great and ever increasing field of engineering with its persistent demand for highly skilled, intelligent mechanics and engineers. It is not enough that a young man be started on such an apprentice course and left to strive along, but rather efforts must be made by the departments to keep up his enthusiasm in the work during those four or five long apprenticeship years, by keeping a definite goal or objective vividly in his view.

A new day has dawned in apprenticeship methods, the day of the self-confident, ambitious and efficient apprentice who can use his head as well as his hands, with the result that a better and closer feeling of loyalty is steadily growing up between the graduating apprentice and his railroad alma mater. But the full benefit will not be obtained from the courses until the apprentices have been educated to grasp the present opportunities and facilities to the limit.

FOUR SUGGESTIONS

BY CARL J. PRYOR
Apprentice, Atchison, Topeka & Santa Fe, Clovis, New Mexico

Without any doubt, the most inspiring and helpful feature of the modern railway mechanical apprenticeship course is the arrangement whereby the training in the shop is supplemented by a study in the school room of mathematics, elementary mechanics, railway shop practice and drafting. No longer is the road to advancement to positions which require a technical education closed to the young man who did not have the opportunity to finish his education before beginning to serve his apprenticeship. The modern apprentice school gives such a young man an opportunity to acquire the first steps in a technical education. It trains him to study and gets him in the habit of studying, so that a boy who is ambitious and anxious to learn has a fair education at the end of four years and the ability to pursue any line of technical study he may desire.

The shop instructor instructs the boy at each new step, sees that he gets a chance to learn all the classes of work in the shop, that he is given fair treatment by all, and that the apprentice behaves himself, both while in the shop and off duty.

Following are a few practices which, in the writer's opinion, could be altered and be of practical benefit to the railroad:

(1) The greatest aid would be actually to convince all the officers, from the highest to the lowest, that the only way to insure a supply of intelligent, competent and loyal workmen to meet future requirements is to educate and train them in the present.

(2) There is too great a tendency to entirely excuse the apprentice for all his mistakes in judgment and work. There are foremen who are afraid honestly to criticize an apprentice, unless the case is serious, for fear they will be misunderstood by the higher officers and be considered as too hard on the boys. An apprentice who is not taught responsibility will become a mechanic that cannot always be relied upon.

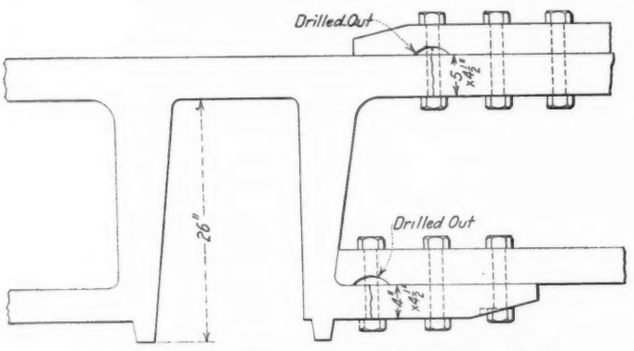
(3) The length of the apprenticeship should be made variable, with perhaps a fixed minimum, or the scope of the work the apprentice is to learn should be made variable. With the present system the idea seems to be to hold each boy on each class of work about the same length of time regardless of his ability. This plan must work to the detriment either of the bright, hard-working, quick-learning boy, or the slower, less gifted one.

(4) Make the shop instructor, not the foreman, absolutely responsible for the work done by the apprentices. This causes the instructor to break in the apprentices in such a way that they will not slow down the work and thus does away with the average foreman's main objection to the apprentice.

A DOUBLE THERMIT WELD

BY ROBERT W. MILLER
Foreman Blacksmith, Cincinnati, Hamilton & Dayton, Cincinnati, Ohio

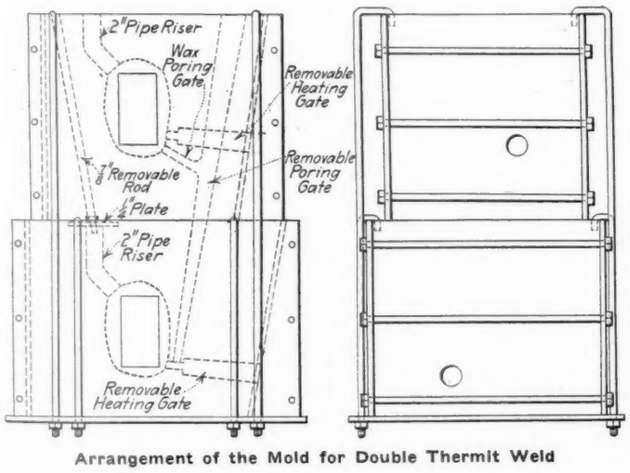
Recently we received two locomotives at the Ivorydale shops of the Cincinnati, Hamilton & Dayton, each of which had two broken frame rails, the breaks being located one above the other in the top and bottom rails of the main frame just in front of the forward pedestal jaw. As no other repairs were required on the engines and they were needed in service the possibility of Thermit welding both breaks at one time suggested itself as a means of reducing the time that they would be held in the shop. As there would be difficulty in securing the right amount of expansion on the second weld if the job were completed in two welds, which would not be



Location of the Fractures in the Main Frame Rails

experienced were both fractures to be welded at the same time, it was decided to use one crucible and make both welds in the same mold. For this work but one pair of wheels was dropped and the crosshead was disconnected but not removed, the guides being left in position.

The fractures were first drilled out to a width of one inch and the metal of the front rails also removed, as shown in the sketch of the frame, to allow a free flow of the welding metal and to assist in reinforcing the main frame at the welds. A



Arrangement of the Mold for Double Thermit Weld

bar of iron 2 in. by 4 in. in section was placed across the engine against the back cylinder heads and the pedestal binder put in place. By means of a jack, placed between the front end of the binder and the bar, an equal expansion of 3/16 in. was secured on both rails. A box was then built up around the bottom rail, just as it would have been if but the one weld were to have been made. The wood pouring gate, however, was long enough to extend up to a point above the riser on the top weld. With the wax mold in place about the lower fracture this box was filled and tamped with the usual mixture of one part fire clay and two parts sand, the top of the riser being covered with a ¼-in. plate, through the center of which a hole was drilled. This was closed by a ⅞-in. rod, the end of which was reduced in diameter to fit the hole in the plate. The top box was made 2 in. smaller all around than the lower box, the two being held together with the tie rods, as shown. A wax connection was made from the main pouring gage to the top mold and the upper box was filled and tamped in the usual manner, the vent in the plate over the lower riser being closed with the ⅞-in. rod. The risers in each case were formed of 2-in. pipe.

With the mold complete the frames were preheated with two torches, one being used in each of the heating gates. The ⅞-in. rod was removed to facilitate the proper heating of the lower frame rail and to vent the lower mold while pouring. The success of this arrangement is attested by the fact that the lower rail reached the desired temperature first.

The welds required 175 lb. of Thermit mixture and were both successful, the engine being held out of service but little longer than what would have been required for one weld.

THE MAINTENANCE OF THE LOCOMOTIVE BOILER

BY A. R. HODGES
General Foreman Boilermaker, St. Louis & San Francisco; Memphis, Tenn.

Before an engine is placed in service after being turned out of the back shop, the roundhouse inspectors should give it a thorough examination. The front end appliances, ash pans and grates, fire box and tubes should receive special attention. Of course this has already been done by the back shop inspectors, but the roundhouse inspector should check up all the work performed in the back shop from the maintenance point of view. For it is the roundhouse force which from now on will have to do with the upkeep of the boiler, and upon whom will rest the responsibility for properly maintaining the locomotive in serviceable condition. No mechanical man engaged in construction and repair work in the back shop can hope to make the success he should, except that he keep himself in touch with the roundhouse conditions and the performance of the locomotive while in service.

An essential element in the proper maintenance of the locomotive boiler, is to maintain an even temperature as near as possible at all times. It is detrimental to the upkeep of the locomotive boiler to open the fire door when it is permitted to "pop," as this reduces the temperature of the fire box and contraction sets in. This is liable to result in leaky tubes. For the same reason an engine should not be permitted to drift without keeping a white fire in the fire box while doing so. An injector should not be in operation when the engine is popping unless there is a hot fire in the fire box at the same time. Enginemen should endeavor to leave their engines at the cinder pit with a full boiler of water and a good fire in order that the hostlers will not be compelled to fill the boiler just previous to blowing off the steam. The water should never be raised after the fire has been dumped and the engine is placed in the roundhouse. All these precautions should be exercised to avoid abrupt changes in temperature, which are the cause of more leaky tubes than almost any other factor. Moreover, any condition necessitating frequent working of the tubes in the roundhouse, greatly reduces their life and leads to an early shopping of the engine.

The prevention of engine failures due to leaky tubes does not rest entirely with the roundhouse boilermakers, regardless of the fact that they are compelled to assume the responsibility. A proper appreciation of the effects of the inequalities of temperature in the locomotive boiler on the part of enginemen and hostlers would bring about considerable improvement.

In working over leaky tubes in the roundhouse, too often

not enough time is taken to perform the work properly. The "hot man" is urged to get the engine ready as soon as possible. Accordingly, therefore, he enters the box with his hammer and beading tool, and hurriedly and in a superficial manner works the leaky tubes. In some instances where it is difficult to hold the beading tool and hit it with his hammer he discards the tool altogether and simply uses the peen of his hammer. No doubt he stops the leaks and the engine leaves the terminal with the boiler apparently in good condition. But the moment the engine begins to work hard, or the temperature is suddenly reduced the flues will begin to leak again, and long before the terminal is reached it may be necessary to reduce the tonnage, or a complete failure may result. If investigation is made to locate the responsibility, the roundhouse boilermaker will try to justify himself by truthfully saying: "She was dry when she left the roundhouse."

Tubes should never be beaded to make them tight. Beading should be resorted to only occasionally and then for the sole purpose of laying the bead back to the sheet where it belongs. Excessive beading flattens the bead, cuts up and destroys the sheet and reduces the tube in thickness until the bead falls off and the tube loses its holding force in the sheet. Because of the improper use of the beading tool three or four different standard sizes are furnished. Size No. 1 is used in the first setting of the tubes in the back shop. The "hot work" man is furnished with a No. 2 beading tool, which is a little larger than a No. 1. As the flues are rebeaded again and again, the beads flatten out until finally a No. 3 or 4 tool is required.

If the boiler repairs have been properly made when an engine comes from the back shop, the tubes will have been swaged to a size requiring two or three good blows with a backing hammer to drive them through the holes in the back flue sheet, leaving 3/16 in. of the ends projecting beyond the sheet to form the beads. This is sufficient to fill a No. 2 beading tool, which is the most generally accepted standard. The No. 1 tool is sometimes used in applying new tubes because it requires but a scant 3/16 in. of material to properly fill it and allows a greater range of tools to take care of the flattening of the bead while the engine is in service. However, the No. 2 bead is more substantial in every respect and should be used at the outset. It should be maintained by refraining from continuous use of the beading tool as a means of caulking leaky tubes and other sizes of tools should be unnecessary.

Rollers are but little better than beading tools in the working of leaky tubes, as they expand the tube only on the fire side of the sheet. Their repeated application also rapidly reduces the thickness of the tubes and thus shortening their life, increases the diameter of the tube holes, cracks the bridges and buckles the sheet. Although the complete prohibition of their use in the roundhouse is often recommended, I believe they may be used with good results if proper care is exercised in determining when to use them. Their complete elimination from the roundhouse and their continuous use in reworking tubes are extremes neither of which are desirable.

In setting tubes with a prosser expander the writer believes that the type *B* tool should be used. The shoulder on a type *A* expander is rather sharp, and has a tendency to shear the tube on the inner edge of the hole, while the type *C* does not have sufficient shoulder to form a substantial joint. The type *A* tool should be used not only in the application of the tubes but in their maintenance for the same reasons that a No. 2 beading tool should be used both in application and maintenance work. In applying the tubes, after they have been prossered they should be given a light rolling. In maintenance, however, the rollers should be used only occasionally. Their application after each prossering is neither necessary nor desirable to secure the best tube service.

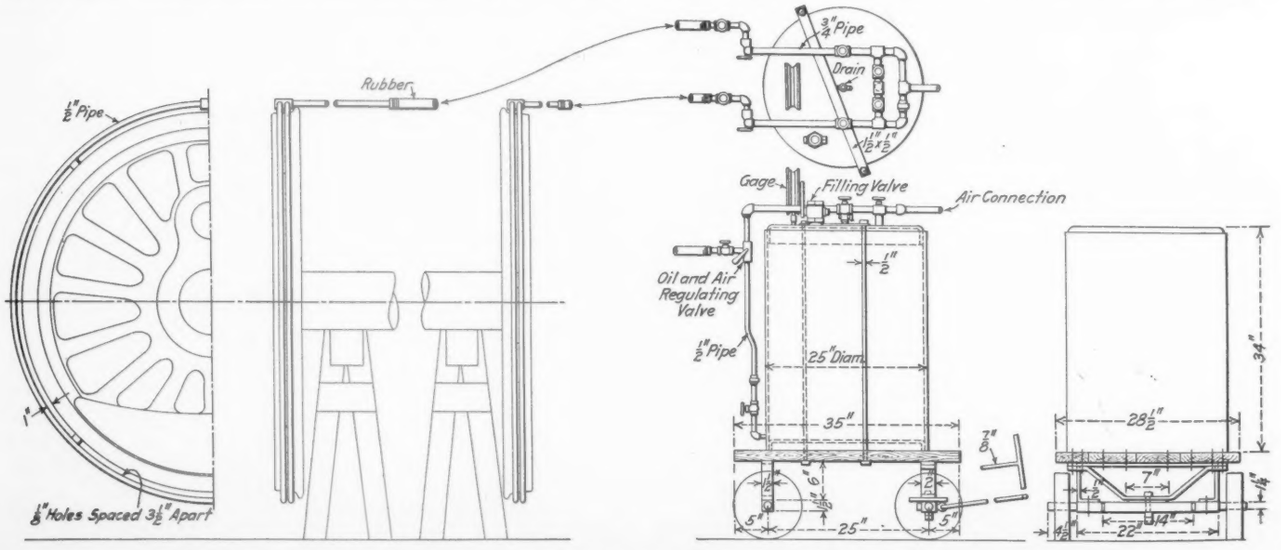
There are many differences of opinion as to the best type of copper ferrule. Many boilermakers believe it should be heavy while others believe it should be light, and the same statement applies to its length. In some instances the best type will be determined by water conditions. The writer has obtained successful results from all types and believes that the selection depends largely on local conditions.

The proper handling of the locomotive when washing out the boiler is another important factor in the maintenance of the boiler. Where improved hot water washing and filling systems are installed, this presents no difficulty, but where hot water is not available considerable care must be exercised to avoid too rapid reduction in the temperature of the sheets. The foreman boilermaker should have entire supervision of all boiler washers and their work.

PORTABLE TIRE HEATER

BY E. A. MURRAY
Master Mechanic, Chesapeake & Ohio, Clifton Forge, Va.

The tire heater illustrated differs from the ordinary tire heater employed in railway shops, in that it is arranged so that two burners can be used at once, so that its capacity is increased 50 per cent. We have found that kerosene is best suited for use in this machine. As seen on the drawing, it



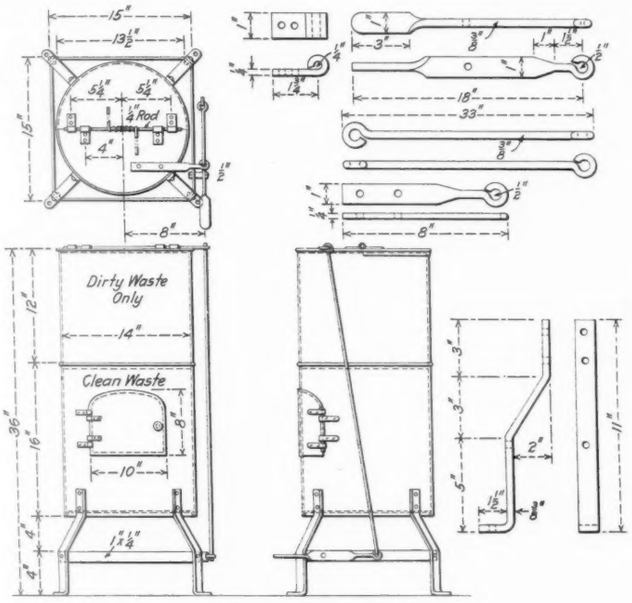
Double Ring Tire Heating Apparatus in Use at the Clifton Forge Shops of the Chesapeake & Ohio

consists of a tank 25 in. by 28½ in. mounted on a four-wheel truck, and the necessary pipe connections. The oil and air regulating valves are at the side of the tank, and the ¾ in. pipes leading from them are connected to the ½ in. heater pipes by flexible connections.

WASTE STORAGE CAN

BY C. W. SCHANE

The sketch shows a type of waste storage can for clean and soiled waste that is discarded, but can be of further use about shops for building fires or cleaning dirty machine parts. This receptacle is fireproof, and is so constructed that it cannot be left open. It is intended for use in engine



Storage Can for Waste

rooms, paint shops, etc., and will prove valuable wherever gasolene is used. It is opened by a series of levers and rods by foot power. It can be built of scrap material such as locomotive jackets or old car roofing.

WHAT CAN BE DONE FOR THE APPRENTICE?*

BY JOHN C. MURDOCK
Boston and Albany, Allston, Mass.

Patience is a great virtue for those who have to do with the training of the ordinary boy. According to the teaching of economics, the subject must be fit, or else the time used is wasted. Let the proper subject come under a poor system of training and education, and an improper subject under a good system of training and education, and I think the one under the good system will surpass the better adapted boy under less favorable conditions.

The greatest drawback to the apprentice, as a rule, is the tendency of having output as the main effort in most American shops. Eagerness to have this output as high as possible tends to keep men on one job all the time, and the apprentice, being one of the men, becomes in many cases a specialist, not a general mechanic.

Any man having experience as a tutor will admit that the more interest he takes in teaching, the more interest the scholar takes in being taught.

*Entered in the competition on "How Can I Help the Apprentice?" which closed September 1, 1915.

An apprentice should be taught the importance of technical knowledge from the moment he starts to learn a trade. This sharpens his mind and makes him think, and also has the effect of increasing his confidence when he finds that the theories for many things are so simple. Many mechanical blunders are made and carried through to a finish from lack of theoretical knowledge.

A suggestion to make in behalf of the apprentice would be to have a sum of money awarded as a prize for the highest percentage received. Also special training should be given students free of charge with opportunity to have time allowed for it when they show exceptional ability. This would be an incentive to strive toward higher positions.

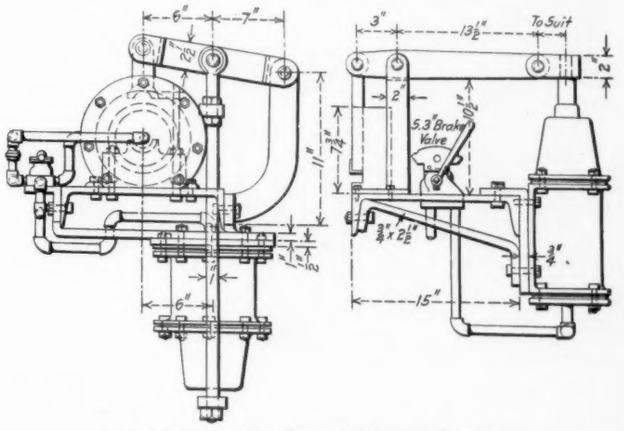
The responsibility for the kind of mechanic turned out should rest upon the man in charge, in the same manner as he takes the responsibility for the machine output. Both are manufactured from raw material. If he is responsible for one, why not the other? Therefore, he should move the apprentice about to develop him and not place too much stress on material output.

HOSE STRIPPING MACHINE

BY R E. BROWN
Machine Shop Foreman, Atlantic Coast Line, Waycross, Ga.

In order to reduce the cost of stripping and remounting air brake and signal hose, a stripping machine has been developed at this point from which excellent results have been obtained. The machine is very simple, both in construction and operation and is made from material usually found around a railroad shop, no special patterns having been required. It is used in cutting, splicing, mounting and stripping both air brake and signal hose, but one change being required for the performance of these operations.

The construction of the machine is clearly shown in the drawing. At one end of the table is a cutter *A*, operated by a vertical air cylinder which may be of any size desired.



End Views of the Hose Stripping Machine

At the center are placed the clamps *B*, in which the hose is secured while having the coupling and nipple removed or applied. These clamps are operated by an 8-in. by 7-in. driver brake cylinder, the thrust of the push-rod being transmitted to the clamp-operating lever by means of the tension rods and yokes shown. The horizontal cylinders *C* and *D*, which are 8-in. by 12-in. brake cylinders, are used to remove and apply the coupling and nipple from the ends of the hose. The operation of each cylinder is controlled by a Westinghouse valve, the type of which is indicated on the drawing.

The first operation in stripping old hose is to cut the clamp bolt on the cutter *A*. The hose is then passed to another man who clamps it at *B* and pulls out the coupling

and nipple by means of the cylinders *C* and *D*. The hose clamps are then struck in the opening with a cross peen hammer to spread them so that they may be easily removed from the hose. While the hose is being stripped, all couplings, nipples and clamps, as well as the hose itself, are inspected, and are placed in boxes for future use. In mounting hose the clamps are first placed in position and the hose clamped in the machine. The coupling is then placed in the holder *E* and pressed into the end of the hose by the cylinder *C*. The nipple is placed in a holder on the piston rod of cylinder *D*, by means of which it is pressed into the hose. The holder *E* is used in both stripping and mounting work, but separate holders are required for use with cylinder *D* in the two operations.

After being mounted, the hose are piled on the end of the clamping machine, which is directly behind the mounting machine, where they are later clamped and the bolts applied, after which they are tested under air pressure. The clamping machine is a simple device in which the clamps are gripped and closed by means of an 8-in. by 8-in. air cylinder.

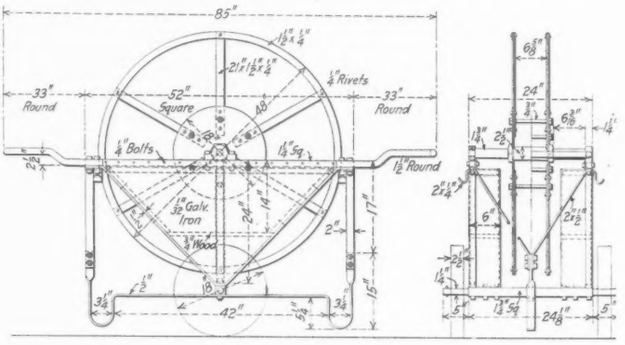
Two men do all the stripping and mounting of hose by means of this machine, including the handling of the hose to the machine and disposing of the parts after the hose has been stripped. They also do any repairing which is required by the clamps and couplings and count and rack the mounted hose. Under these conditions the following performance has been made: One man with a helper has mounted and tested 250 hose in a nine-hour working day.

In stripping, one man and a helper will average 700 hose per day of nine hours. One man with a helper can splice 200 hose in a day of eight hours. One man with a helper will mount, on an average, 300 signal hose in eight hours.

BOILER WASHER'S HOSE CART

BY E. A. MURRAY
Master Mechanic, Chesapeake & Ohio, Clifton Forge, Va.

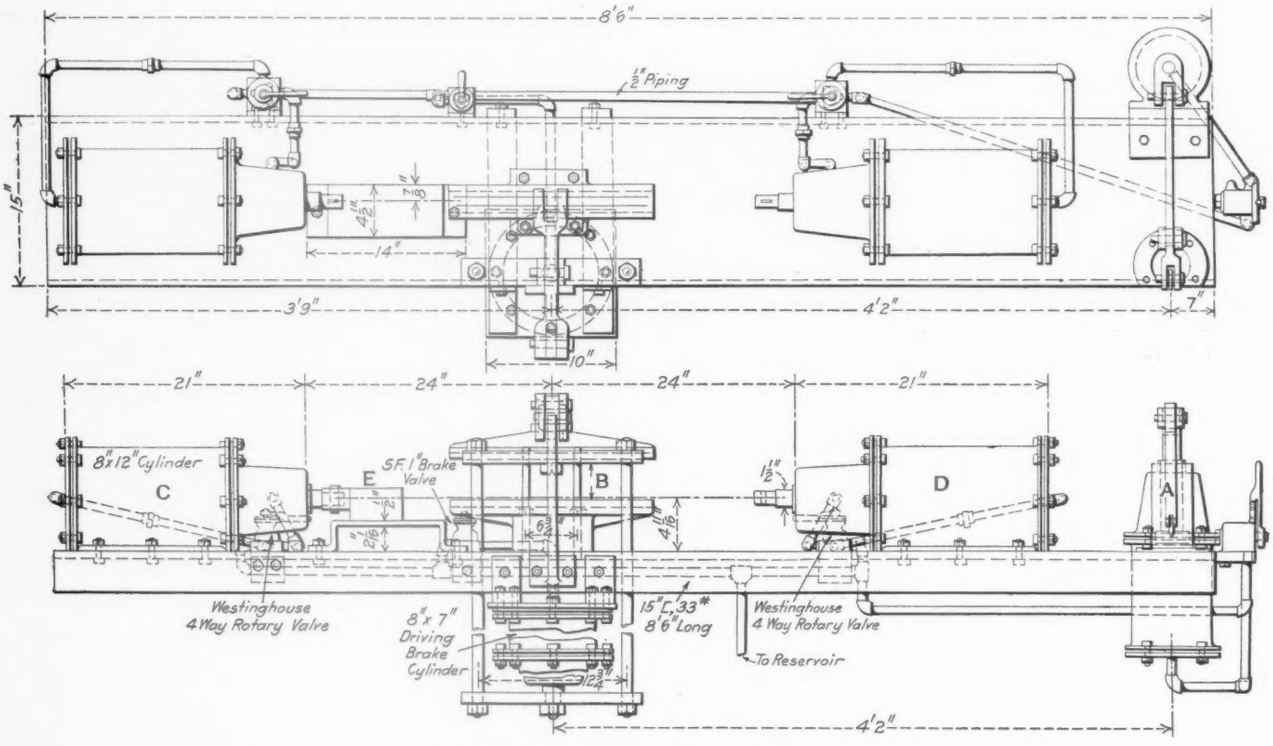
It is not unusual to see the boiler washer dragging the washout hose through the roundhouse, and after he has succeeded in getting the hose to the point where it is to be used, it is necessary to return for the tools. By the use of one of



Washout Hose Car

these hose carts this trouble is eliminated, as it can easily be moved from place to place, and provides suitable means of transporting the washout hose and the other boiler washing tools.

It might be added that a pot of graphite mixed with valve oil is always in evidence with the outfit, this being used on the threads of washout plugs to make their removal easy. There is very generally not enough attention given to the importance of boiler washing.



Machine for Stripping and Mounting Air Brake and Signal Hose

FEED-WATER TEMPERATURE WITH OPEN HEATERS.—In an open feed-water heater the water to be heated is under atmospheric pressure and its temperature cannot be raised above 212 deg. F.—*Power.*

FUEL BRIQUET INDUSTRY IN 1915.—Over a million dollars' worth of briquets were made from waste coal in 1915, the exact production being 221,537 tons, valued at $1,035,716.

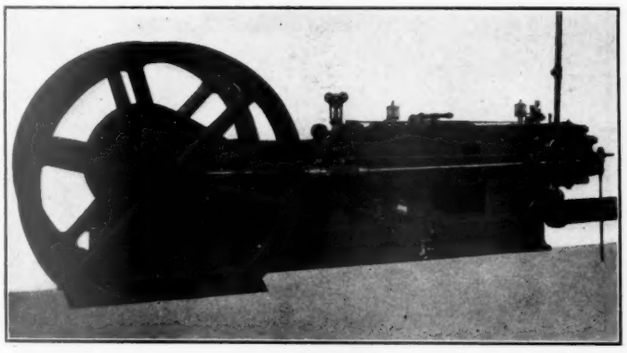
NEW DEVICES

FUEL OIL DRIVEN AIR COMPRESSOR

To produce air compressors with lower operating costs and of lower first cost than any previously known has been the idea of the engineers of the Chicago Pneumatic Tool Company, Chicago, in the development of their Class N-SO fuel oil driven compressors.

These compressors are guaranteed to run on any mineral oil of 26 deg. Beaumé scale or lighter, containing not over one per cent sulphur. There are a number of oils well below this scale on which they will operate satisfactorily, but this depends upon the characteristics of the particular oil. A number of these fuels are obtainable for three cents per gallon, and the compressors are warranted to compress air to 100 lb. per sq. in. at a cost not exceeding 56 cents per day of nine hours for each 100 cubic feet per minute of free air delivered to the receiver. There are many of these machines in service with daily records of fuel consumption that bring their costs of operation well under the amount stated.

These compressors are of the horizontal, straight line, single stage type with compressing cylinder bolted to the main frames and closely connected in tandem to the power ends. The propulsive cylinders are of the valveless, two-cycle, low compression design. Ignition is produced by a



Air Compressor Using Oil as Fuel

patented, positive-acting hot-plate system, that eliminates all electric apparatus such as magnetos, timers, mixers, and spark plugs. As in the Diesel engine, combustion takes place at the end of the compression stroke. Air only is compressed in the cylinder, and combustion is so complete by the time the exhaust port is opened that the fuel loss is negligible. The result is attained through the medium of a small oil pump which injects the fuel against the hot plate on the piston as it approaches the end of the compression stroke. Increased economy is obtained by the use of water with the fuel oil. The quantity of both oil and water admitted to the combustion chamber is controlled by a fly-ball governor. The outstanding features of the compressing cylinders are the patented "Simplate" * flat disc air inlet and discharge valves. They are guaranteed for three years.

N-SO compressors are made in both single and duplex types. Single compressors come in six standard strokes; 8, 10, 12, 14, 18 and 21 in. The smaller sizes may be tank mounted and the larger types set on skids so that their use is not confined to stationary requirements. The adaptability of these machines to severe service conditions renders them particularly attractive to mines and contractors, but they are equally desirable for railroad and industrial shops, for pumping oil and water by various systems, and for use wherever cheap compressed air can be utilized.

*See *Railway Age Gazette Mechanical Edition* for October, 1915, page 545.

DRIVING BOX BRASS

The illustrations show a departure in sectional locomotive driving journal bearings or brasses. The Langton brass, of which there are now 270 in service, has been designed with a view to simplifying the operation of applying and removing such brasses. This operation, heretofore, has involved the shopping of the locomotive, dropping the wheels and otherwise dismantling, with an attendant expense, including the loss of the earning capacity of the locomotive, often amounting to $125 or more. With the use of the Langton brass it is possible to crown a pair of journals in less than two hours, at a cost of less than $3.00, without the use of a

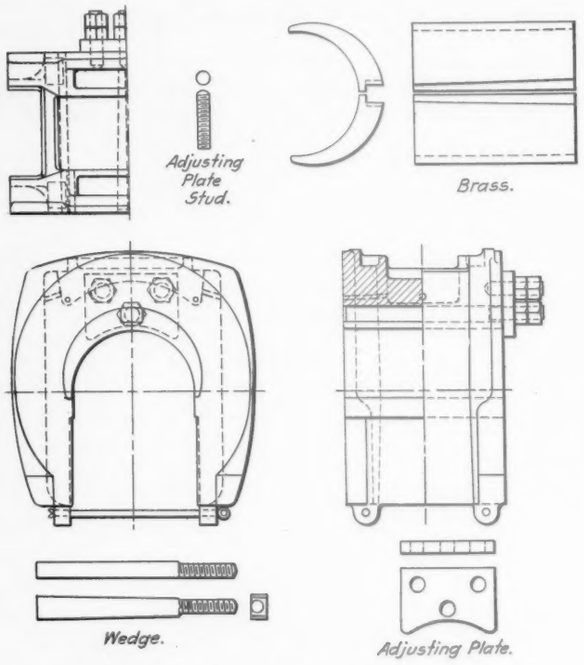
Langton Driving Box Brass

drop pit or any other facilities than a journal jack, making it possible to do the work during the lay-over period, consequently the locomotive need not miss its regular run. Brasses can be closed on the journal in less than 30 min.

No change of existing patterns of boxes or brasses is required. The solid brass is simply split lengthwise and provided with a tapered groove or key-way at the top to receive a tapered key or wedge which forms the adjusting means. A small holding plate fastened to the inside face of the box by means of two studs completes the arrangement. It can be manufactured at any shop having a lathe, planer or shaper, and drilling machine, and can be applied at any roundhouse.

In applying a solid brass the driving box, weighing sev-

eral hundred pounds, has to be handled and trucked a number of times, while with the Langton brass the heaviest part moved is the brass itself. This brass has been in service



Details of the Construction of the Langton Brass

nearly two years on all classes of power and has demonstrated its entire practicability. It has been developed by J. W. Small and G. H. Langton, Portsmouth, Va.

PYROMETER FOR MEASURING TEMPERATURE OF STEEL

The Gibb Instrument Company, Highland Bldg., Pittsburgh, Pa., has placed on the market a departure from the

Pyrometer and Its Method of Use

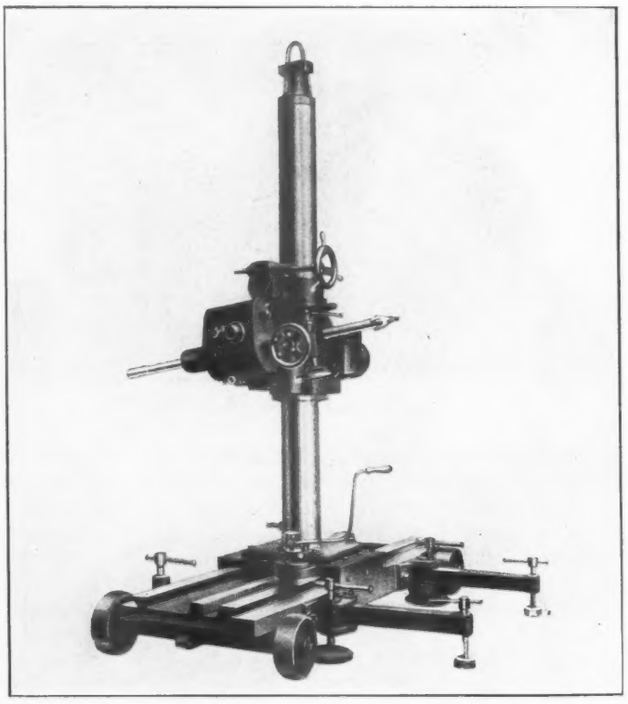
ordinary thermo-electric pyrometer, known as the "I-Rite." Its principal claim for distinction is that while the thermo-electric pyrometer indirectly measures the temperature of the material under heat by measuring furnace temperatures, the new instrument directly measures the temperature of the piece. The instrument is of pocket size, simple, accurate and inexpensive.

It is claimed that this pyrometer will exactly duplicate the color of heated bodies and at the same time indicate the temperature on an accurately calibrated scale. It is possible for the user to read the temperature of the piece under treatment within one to two per cent, regardless of the furnace temperature. It is not necessary to take into account the length of time the body has been subjected to the specified temperature in order that it may assume this temperature. The pyrometer immediately shows either that the piece is or is not up to temperature and, in the latter event, how many degrees it must be raised.

The operation is simple and the instrument can safely be placed in the hands of an unskilled workman. The construction is claimed to be such that it cannot get out of order. While it is designed for the more precise temperature measurements of high grade steels under treatment, inasmuch as it is made in two ranges, 1,000-1,800 deg. F. and 1,800-2,300 deg. F., it can also be used for taking the temperature of heated bodies either within or without a furnace.

PORTABLE DRILLING AND TAPPING MACHINE

The portable, electrically operated drilling and tapping machine shown in the illustration, is handled by the Wiener Machinery Company, 50 Church St., New York. These machines are intended chiefly for use in locomotive repair



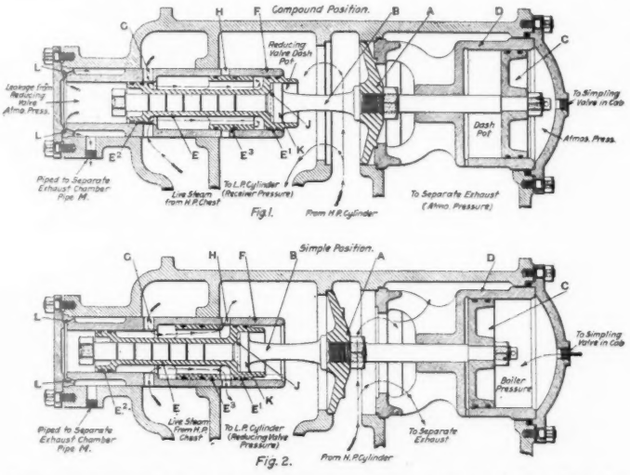
Portable Drilling and Tapping Machine

shops. They can be moved directly to the place where they are to be used and can be put into operation without any installation work. The fastening of the drill to the object to be drilled is avoided, and in the drilling of small and medium-sized holes the weight of the machine is enough to counteract the drilling pressure. For larger holes and in case the drillhead is on top of the column, the machine is supported by the turnable arms mounted on the bedplate. For fixing the machine to the floor, four heavy plate screws are provided.

The drilling spindle is driven by a three horsepower electric motor which is located near the drilling head. A double acting worm gear and a compound gear are provided so that four cutting speeds can be obtained. The drilling-head is turnable around the horizontal axis and can be swiveled 360 deg. around the column and also can be moved up and down; besides this the column with its footplate can be moved horizontally along the carriage bedplate. The spindle therefore can be adjusted in every direction. The machine drills holes up to 1½ in. into the solid and taps up to 1¼ in. By the use of a boring bar, holes up to 4 in. in diameter can be drilled. The up-and-down movement of the drilling gear on the column is accomplished by motor power.

INTERCEPTING VALVE FOR MALLET LOCOMOTIVES

In the accompanying drawings are shown the details and method of operation of an intercepting valve which has recently been developed by the Economy Devices Corporation, New York, for use on Mallet compound locomotives. It is known as the Simplex intercepting valve and is shown as applied to cylinders which are cast integral with half saddles. It is enclosed in a separate lagged and jacketed casing in



Sections Showing the Construction and Operation of the Simplex Intercepting Valve

front of the cylinders, with separate connections to each. This arrangement permits the use of the same pattern for both right and left cylinders, the openings in the rear walls being closed by special caps as shown in one of the illustrations. It may readily be adapted for use with cylinders which are attached to a separate saddle casting, in this case it being possible to provide the necessary passages and chambers for the operation of the valve inside the saddle itself.

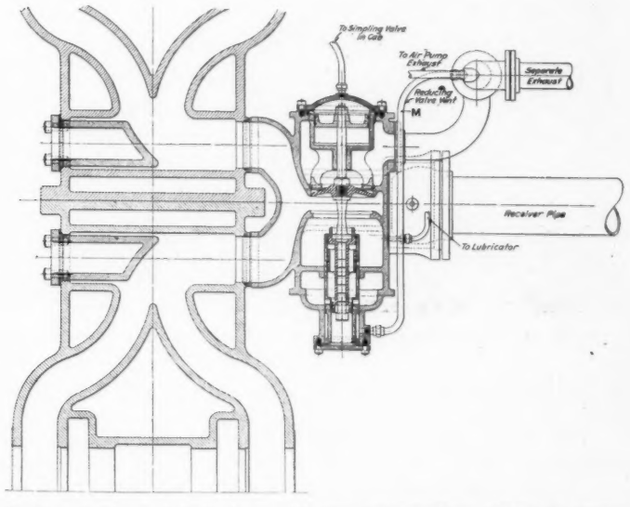
By referring to the drawing showing the operating positions of the valve it will be seen that the casing is divided into four chambers communicating respectively from left to right with the live steam chamber of the high pressure steam chest, the receiver pipe, the exhaust passages of the high pressure cylinders and a separate exhaust pipe leading to a removable annular nozzle surrounding the main exhaust nozzle. The exhaust steam from the high pressure cylinders is controlled by the main valve *A* which causes it to flow into the receiver chamber and thence to the low pressure cylinders when the engine is working compound and through the separate exhaust chamber to the atmosphere when working simple. The intercepting valve stem on which this valve is secured is extended to the right, the end carrying a piston *C* operating in the cylinder *D*. Live steam is admitted to the outer face of the piston by placing the operating valve in the cab in the position marked "Simple," thus forcing the operating parts into the position shown in Fig 2. The inner end of the cylinder serves as a dash pot and prevents shock in the movement of the valve.

At the left end of the valve stem is a differential piston valve *E* which controls the admission of live steam to the low pressure cylinders. This valve has a movement of one-half inch on the stem, the latter having a traverse of three inches. It works in a bushing through which are ports communicating with the live steam and receiver chambers, port *G* admitting live steam to the annular space between the two pistons and port *H* admitting live steam to the low pressure cylinders under control of the reducing valve.

Referring to Fig. 2, showing the intercepting valve in simple position, it will be seen that until pressure is built up in the receiver pipe the reducing valve will occupy the position shown, owing to the greater area of piston E^1 as compared with piston E^2. As soon as the predetermined pressure has been built up in the receiver pipe, however, it reacts on the outer end of the piston E^1, causing the valve to move to the left on the stem and closing port *H*. The width of the opening through this port will thus be automatically regulated to meet the requirements of the low pressure cylinders at a constant receiver pipe pressure.

When the pressure is released from cylinder *D* the tendency of the reducing valve to move to the right is utilized to move the main valve from its simple to its compound position. At the outset this movement is aided by the action of the receiver pipe pressure against the piston *A*. When the valve moves from simple to compound position the interminate piston E^3 moves over the port *H* and closes it as shown in Fig. 1.

The control of the power exerted by the high pressure cyl-



Sectional Plan of Cylinders with the Intercepting Valve in Place

inder when working simple is effected by changing the size of the annular exhaust nozzle. The small end of the reducing valve is vented to the atmosphere through the pipe *M* which leads into the high-pressure exhaust pipe. The smaller the exhaust nozzle the greater the back pressure acting on the high pressure piston; this in turn, acting through the pipe *M* against the small reducing valve piston, increases the receiver pipe pressure and adds power to the low pressure cylinder. Should the high pressure engines slip when working simple, the resulting increase in back pressure will produce the same effect, temporarily increasing the pressure admitted to the low pressure cylinders and thereby tending to maintain a uniform total drawbar pull.

Care has been taken in designing this valve to facilitate

removing it for inspection or repairs. The entire mechanism including the operating cylinder *D* may be removed by taking off the cylinder head, the arrangement being such that the work may be done from the ground without going between the locomotive frames. This work may be done with no other tools than a monkey wrench.

KO-SHOVEL MECHANICAL STOKER

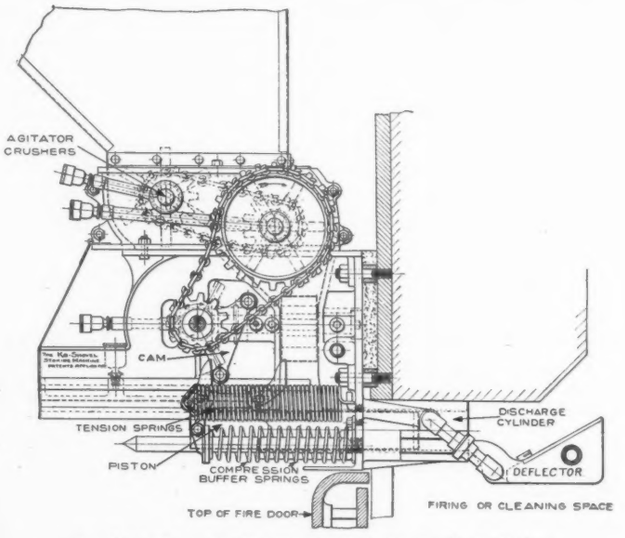
A new scatter type stoker for stationary boilers has been placed on the market by the Goetz Company, Chicago. The stoker is installed either directly in the upper portion of the fire door opening or immediately above the door in the boiler front. The entering chute and plunger occupy a space but 5 in. deep, and when installed in the fire door opening a new door is provided. The installation does not prevent, or interfere in any way with firing by hand, or cleaning the fire through the fire door. The coal is fed to the hopper of the stoker, as shown in the photograph, and from there passes through a pair of agitator crushers to a rotary coal valve. This valve regulates the flow of the crushed coal to the discharge cylinder, where it is ejected onto the grate by means of a spring actuated plunger, the coal passing over a water-

Ko-Shovel Mechanical Stoker Applied to a Battery of Boilers

cooled deflector suitably arranged to properly scatter the coal over the grate.

The rotary valve is simply a disc with two diametrically opposite pockets which take the correct amount of coal from the crusher chamber and deliver it to the discharge cylinder. The plunger is driven by two compression springs and is pulled out to the charging position by means of a cam, as indicated in the drawing. The gearing is so arranged that as the plunger is pulled back the rotary coal valve delivers its charge to the discharge cylinder. By the time the second cam roller disengages from the second lug on the plunger the rotary valve is closed and the coal is in the cylinder ready to be discharged. A compression spring is provided, as indicated, to serve as a buffer for the plunger at the end of the stroke.

The stoker may be driven by either a steam engine or an electric motor or by a belt from a line shaft. When a steam engine or motor is used the speed at which the stoker is operated may be regulated by an automatic regulator controlled by the pressure of the steam in the boiler. The coal hoppers are designed to hold one hour's supply of coal and the coal is fed to the grate in one-half pound charges. This stoker will fire successfully any grade of fuel between 1½ in. bar screening and No. 5 washed or unwashed coal. With the stoker better combustion of the fuel is obtained, due to the



Section Through the Ko-Shovel Mechanical Stoker

fact that the charges are small and frequent and that the fine dust particles are completely burned almost before they reach the grate. Exclusive sales rights for this machine are held by George A. Kohout & Company, Monadnock building, Chicago.

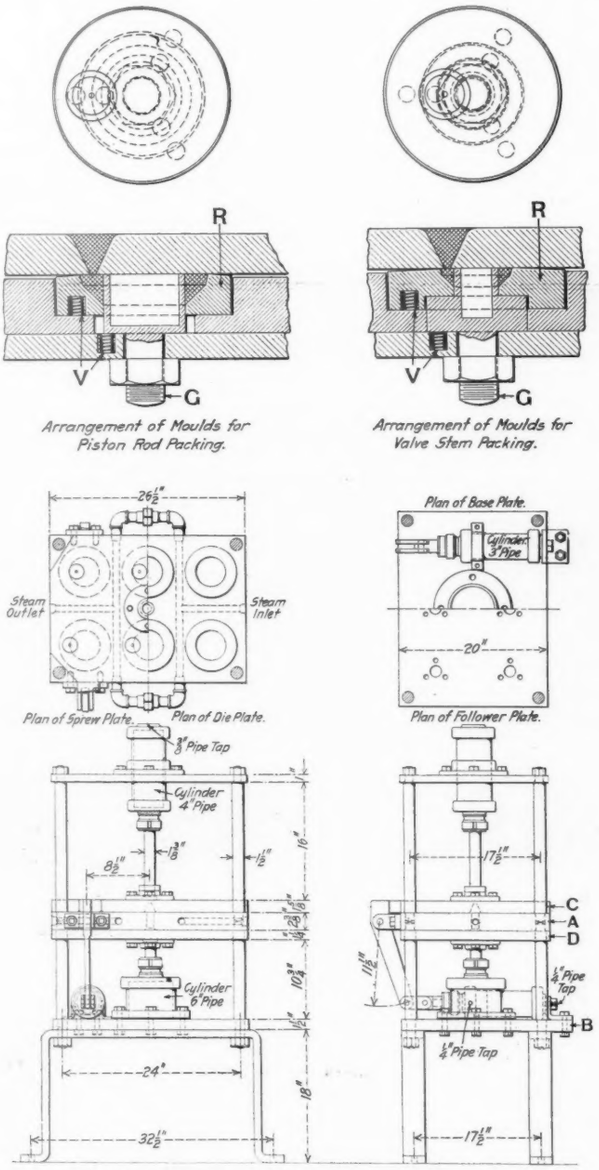
MOLDING METALLIC PACKING FOR SATURATED STEAM LOCOMOTIVES

It has long been the practice to machine all metallic packing to fit the vibrating cup, but errors are bound to creep in, even if the most perfect gages are used in the finishing. By means of the machine here shown, metallic packing can

Machine for Making Metallic Packing

be molded to the exact finished size ready to be cut and put in the vibrating cup. An allowance of 1/8 in. is made for piston or valve rod fit. This machine not only does away with bad fitting packing, but reduces the labor cost very materially, and in cases where leaks occur, the cause can be traced back to imperfect angles of the cup or to some other defect, instead of blaming the packing.

One of the illustrations shows a front and side elevation as well as a top view of plate *A*, which is counterbored to receive the steel molds and rigidly held in position. The



Details of Machine for Making Metallic Packing

pneumatic cylinder for shearing the gates is bolted to *B*. The machine can be operated either by steam or air but on account of the condensation from steam, air is preferable.

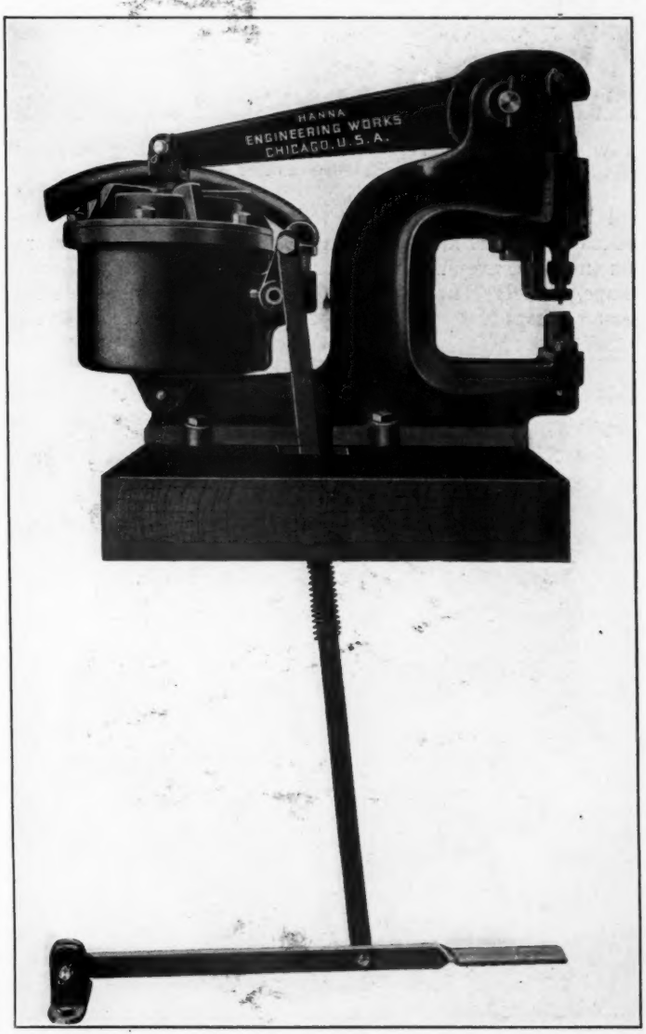
Two cylinders are used to raise and lower plates *C* and *D* by means of a four way valve which will allow air to pass into the head ends of both cylinders to close *C* and *D* against *A*, or the opposite sides of the pistons to open plates *C* and *D*. When *C* and *D* are closed against *A* and the plugs *G* and molds *R* are in proper place, the metal can be poured through the gates in the plate *C*. After the metal sets, plate *C* shears the gates and air is admitted to the rod side of the pistons, thereby causing plates *C* and *D* to move away from *A* allowing the operator to remove the packing from the molds. In order that the packing may be free from fins, the molds and plungers are set on springs *V*, which take up any variation in alignment between *A*, *B* and *C*.

This machine has been in continuous service for six months and during this period one operator produced a daily average of 350 sets of packing. The dotted lines through *A* and marked "steam inlet" and "steam outlet" are passages for steam used to heat the dies and to keep the temperature uniform.

This device was developed by F. J. Dailey on the Erie Railroad and a patent has been applied for.

PNEUMATIC PUNCH AND RIVETER

The pneumatic punch and riveter shown in the accompanying photograph may be used either as a portable or a stationary machine and is a tool which is suitable for any shop doing light punching or riveting. It has a punching capacity of 3/16 in. to ½ in holes in ¼ in. plate at 90 lb.



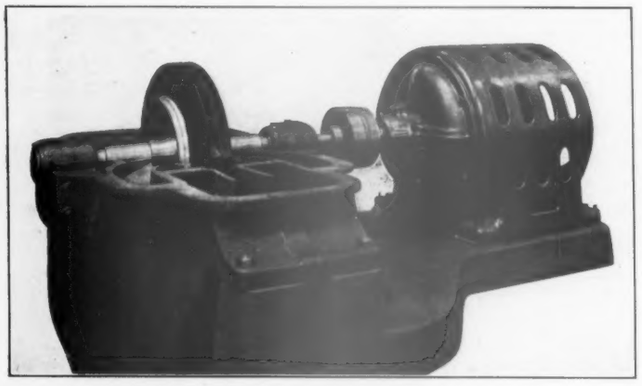
Pneumatic Machine for Light Punching and Riveting

air pressure and will satisfactorily drive ¼ in. rivets cold. A specially designed cushion in the top head prevents shock after the punch has passed through the plate. The frame, the main lever and the plunger are steel castings, the cylinder

parts being chiefly of cast iron. The machine weighs 225 lb. and consumes 1.26 cu. ft. of free air per stroke. It is manufactured by the Hanna Engineering Works, and distributed through the Vulcan Engineering Sales Company, Chicago.

TURBO-BLOWER

The Ingersoll-Rand Company, New York, has added to its turbo-compressors and blowers a low pressure machine for volumes of from 3,000 to 35,000 cu. ft. per minute at from 1 to 2½ lb. pressure. These are particularly adapted to such service as foundry cupola blowing, atomizing oil for



Low Pressure Type Turbo-Blower with Upper Casing Removed, Showing Double Flow Enclosed Impeller

oil burners, supplying blast to heating and annealing furnaces of various kinds, blowing air for water gas generators, pneumatic conveying and ventilating. They are of the single stage, double flow type and are furnished either electric motor, steam turbine or water wheel driven. Electric drive is

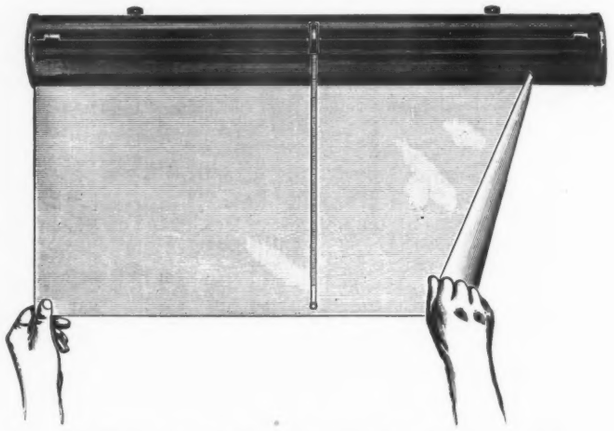
Ingersoll-Rand Low Pressure Type Turbo-Blower

generally employed for the classes of service mentioned and in the case of the I-R turbo-blower, the high operative speed permits direct coupling to the motor. This motor-driven blower maintains constant pressure while delivering any volume from zero to maximum demand and proportionately varying the electrical horsepower input.

These blowers embody the four bearing construction featured in all turbo machines of this make. The casing is horizontally split for ease in installation and subsequent inspection. The assembled casing is doweled and bolted to a heavy sub-base which ordinarily serves for both blower and driving element. The I-R machine occupies small floor space and its lack of vibration in operation obviates the necessity for foundation bolting. The impeller is of the enclosed double flow type, which is claimed to secure the highest efficiency. The wheel is machined from a solid, special steel forging. The vanes and covers are of pressed steel securely riveted. All rivet heads are driven flush and the entire assembly is polished. Every care is taken to reduce skin friction. All impellers are over-speeded in a testing machine to insure correct balance, strength and eliminate vibration. Impellers are keyed to a heat treated, forged steel shaft. Labyrinth packing is employed to prevent leakage between impeller and casing. The bearings are ring oiled and both bearings and their housings are horizontally split. The use of flexible couplings between the blower and the driving unit is standard practice on all I-R turbo-blowers. The machines are all of the closed intake type. The intake opening is at the bottom and the discharge at the top. There are no rubbing surfaces in the I-R turbo-blower, precluding the necessity for adjustment to take up wear and minimizing the cost of maintenance. The only lubrication necessary is that of the bearings, all other parts working without friction.

PROTECTING BLUE PRINT PAPER

The Security tube, shown in the illustration, has been brought out by Kolesch & Co., 138 Fulton St., New York, for storing and protecting blueprint paper, tracing linen and drawing paper. The tube is made in three lengths, 30, 36 and 42 in., of heavy tin japanned black. It tends to eliminate waste and loss of time and avoids the inconvenience of opening and closing the tube every time paper or cloth is required. The paper is placed in the tube by pushing back the slide cover and closing it, the paper remaining protected



Container for Blue Print Paper and Tracing Linen

without again opening the tube until the entire roll has been used.

When a sheet of specified length is to be used, a spring measuring tape, which is attached to the tube, is drawn to the required length, the paper or cloth drawn out and cut by means of a straight cutting edge provided for the purpose.

The tube is provided with brackets so that it can be fastened to the wall, or it may be fastened to a drafting table, as desired.

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NEWS DEPARTMENT

CORRECTION

In the article on the "Diameter of Driving Axle Journals" by L. R. Pomeroy, in the April number, a typographical error appears in the footnote in the second column on page 171. The character surrounding the expression for the diameter of axle d should indicate the cube root and not the square root.

ORDERS FOR CARS AND LOCOMOTIVES IN APRIL

The orders for cars and locomotives in April were considerably below the average which had been set during the last quarter of 1915 and the first quarter of the present year. It is becoming evident that the high prices for steel and other materials going into the construction of railway equipment are acting as a damper on the equipment market. The orders reported during the month were as follows:

	Locomotives	Freight Cars	Passenger Cars
Domestic	178	7,228	101
Foreign	12	1,000	...
	190	8,228	101

Among the important locomotive orders were the following:

Road	No.	Type	Builder
Chicago Great Western	3	Pacific	Baldwin
	7	Santa Fe	Baldwin
Norfolk & Western	20	Mallet	American
Philadelphia & Reading	20	Mikado	Baldwin
	6	Mallet	Baldwin
St. Louis & San Francisco	10	Pacific	Baldwin
St. Louis Southwestern	20	.....	Baldwin
Southern	30	Santa Fe	Baldwin
	15	Mountain	Baldwin
Pekin Hankow (China)	10	Consolidation	American

Of the 7,228 freight cars ordered for domestic service, 3,857 were on orders placed by the Southern Railway as follows: 1,750 box cars, American Car & Foundry Company; 1,500 box cars, Mount Vernon Car Manufacturing Company; and 1,007 box, 500 automobile and 100 caboose cars, Lenoir Car Works. The Wabash placed an order for 1,000 box car bodies with the American Car & Foundry Company.

The Southern Railway ordered nearly all the 101 passenger cars reported during the month, that company having given the Pullman Company an order for 92 cars, including 45 coaches, 13 passenger and baggage cars, 19 baggage and express cars, 10 mail and baggage cars and 5 club cars.

THE JUNE CONVENTIONS

Oscar F. Ostby, president of the Railway Supply Manufacturers' Association, has named the following as members of the nominating committee: George M. Basford, Loco-

motive Pulverized Fuel Company, New York; Charles C. Pierce, General Electric Company, Boston, Mass.; B. E. D. Stafford, Flannery Bolt Company, Pittsburgh; Harry Frost, Frost Railway Supply Company, Detroit; L. F. Wilson, Bird-Archer Company, Chicago; George L. Morton, Galena Signal Oil Company, Atlanta, Ga., and Clarence H. Howard, Commonwealth Steel Company, St. Louis.

In addition to the officers, nominations will have to be submitted for five members of the executive committee. These will succeed in the first district: C. B. Yardley, Jr., Lubricating Metals Company, New York, and J. C. Currie, Nathan Manufacturing Company, New York, who are retiring members; in the third district, C. E. Postlethwaite, Pressed Steel Car Company, who retires on account of having moved from Pittsburgh to New York, or out of the district; in the fourth district, C. F. Elliott, Acme White Lead & Color Works, Detroit, whose term will have expired, and in the fifth district, Joseph H. Kuhns, Republic Rubber Company, Chicago, whose term also expires.

MEETINGS AND CONVENTIONS

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—The fourth annual convention of this association will be held at the Hotel Sherman, Chicago, on May 22-24. The following subjects will be considered: Sheet Metal Work and Machinery; Acetylene in the Tin Shop; The Use and Abuse of Pipe Fittings; Wrought Iron and Steel Pipe; Standard Piping and Clamping; Jackets; Ventilation and Heating of Steel Coaches; Oil Burning Engines and Appliances; Smoke Prevention Devices; Shop Practice; Concentration and Lost Motion.

American Railway Tool Foreman's Association.—The convention of the American Railway Tool Foreman's Association will be held on August 24-26, at the Hotel Sherman, Chicago. The following subjects will be presented by the committees: Heat Treatment of Steel, Henry Otto, chairman; Special Tools for Steel Car Repairs—Devices for Reclaiming Material, J. W. Pike, chairman; Special Tools and Devices for the Forge Shop, G. W. Smith, chairman; Emery Wheels as Applied to Locomotive Repairs, A. Sterner, chairman; Jigs and Devices for Enginehouses, F. D. West, chairman.

Master Boiler Makers' Association.—The tenth annual convention of the Master Boiler Makers' Association will be held at the Hotel Hollenden, Cleveland, Ohio, on May 23-26, 1916. The following is a list of the subjects to be presented and the committee chairmen: Cleaning and Maintaining Superheater Tubes, T. F. Powers; Removing and Replacing Wide Fireboxes, B. F. Sarver; Basic or Acid Steel for Fireboxes, James C. Clark; Cleaning Boilers with Tubes Removed, George Austin; Cracking of Barrel Sheets, C. R. Bennett; Bulging of Front Tube Sheets, J. B. Tate; Advantage of Cutting Off Stay Ends with Oxy-acetylene, Thomas Lewis; Rules for Arriving at Maximum Heating Surface, C. P. Patrick; Fusible Plugs in Crown Sheets, A. R. Hodges; Standard Thickness of Copper Ferrules for Good and Bad Water Districts, W. H. Laughridge; Do Long Tubes Vibrate in Service, C. L. Hempel; Oxy-acetylene and Its Advantages in Boiler Repairs, John Harthill; Electric Welding and Its Advantages in Boiler Repairs, P. F. Gallagher; Prevention of Cracking in Side Sheets, T. P. Madden.

International Railway Fuel Association.—The eighth annual convention of the International Railway Fuel Association will be held on May 15-18, at the Hotel Sherman, Chicago. The following is a list of the papers to be discussed and their authors: Care of Locomotives and Boilers with Relation to Fuel Economy, A. N. Willsie; Psychology of the Fireman, Ralph Bradley; Interpretation of Coal Analysis with Special Reference to Non-Combustibles, E. G. Bailey; The Transportation Department and Fuel Economy, W. H. Averell; The Functions of a Railroad Fuel Inspector, E. McAuliffe; Method of Illustrating Value of Components of Coal, A. G. Kinyon; Fuel Distribution Record System, J. G. Crawford. There are also the following committee reports: Powdered Coal; Fuel Stations; Storage of Coal; Fuel Accounting; Firing Practice; Fuel Tests; Front Ends, Ash Pans and Grates. It is not yet known who will make the opening addresses. At the banquet which will be given on May 17, George A. Post, president of the Railway Business Association, will deliver the address of the evening. At other times during the convention addresses will be made by M. P. Blauvelt, controller, Illinois Central Railroad; Samuel O. Dunn, editor, *Railway Age Gazette,* and J. W. Higgins, chairman, General Managers' Association, Chicago.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Convention, May 2-5, 1916, Hotel Ansley, Atlanta, Ga.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—W. E. Jones, C. & N. W., 3814 Fulton St., Chicago. Convention, May 22-24, Hotel Sherman, Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago. Convention, June 19, 1916, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—Owen D. Kinsey, Illinois Central, Chicago. Convention, August 24-26, 1916.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa. Convention, June 27-30, Traymore Hotel, Atlantic City, N. J.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago. Semi-annual meeting, Hotel Denis, Atlantic City, N. J., June 16.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawlor Ave., Chicago. Second Monday in month, except June, July and August, Hotel La Salle, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. R. McMunn, New York Central, Albany, N. Y. Convention, October 3-5, Indianapolis, Ind.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 547 W. Jackson Blvd., Chicago. Convention, May 15-18, Hotel Sherman, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, August 29-31, 1916, Hotel Sherman, Chicago.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August 15-17, 1916, Hotel Sherman, Chicago.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York. Convention, May 23-26, 1916, Hollenden Hotel, Cleveland, Ohio.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago. Convention, June 14, 1916, Atlantic City, N. J.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September 12-14, 1916, "The Breakers," Atlantic City, N. J.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. Frankenberger, 623 Brisbane Building, Buffalo, N. Y. Meetings, third Wednesday in month, New York Telephone Bldg., Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May 15-17, 1916, Hotel Statler, Detroit, Mich.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio. Convention, September 5-8, 1916, Chicago.

RAILROAD CLUB MEETINGS

Club.	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	May 9	Annual Meeting; Election of Officers	.....	James Powell	St. Lambert, Que.
Central	May 11	Modern Superheaters	S. S. Riegel	Harry D. Vought	95 Liberty St., New York
Cincinnati	May 9	Locomotive Feed Water Treatment	L. F. Wilson	H. Boutet	101 Carew Bldg., Cincinnati, O.
New England	May 9	.....	.....	Wm. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	May 19	Lighterage	H. L. Joyce	Harry D. Vought	95 Liberty St., New York
Pittsburgh	May 26	Advantages of Railroad Test Department	C. D. Young	J. B. Anderson	207 Penn Station, Pittsburgh, Pa.
Richmond	May 8	Automatic Stop and Train Control	Stephen Smith	F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	May 12	Tests of Bridge Timbers and Ties	H. F. Weiss	B. W. Frauenthal	Union Station, St. Louis, Mo.
South'n & S'w'rn	.....	.....	.....	A. J. Merrill	Box 1205, Atlanta, Ga.
Western	.....	.....	.....	Jos. W. Taylor	1112 Karpen Bldg., Chicago.

PERSONAL

GENERAL

H. D. CAMERON has been appointed mechanical engineer of the Canadian Northern, with office at Toronto, Ont.

M. JEFFERSON, assistant master mechanic of the New Jersey and Lehigh division of the Lehigh Valley at Easton, Pa., has been appointed master mechanic of the Auburn division at Auburn, N. Y.

A. T. KUEHNER has been appointed motive power inspector of the main line district of the Baltimore & Ohio.

THOMAS LEWIS, master mechanic of the Auburn division of the Lehigh Valley at Auburn, N. Y., has been appointed general boiler inspector for the system, with headquarters at Sayre, Pa.

H. H. MAXFIELD, master mechanic of the Pittsburgh division of the Pennsylvania Railroad, has been appointed superintendent of motive power of the Western Pennsylvania division.

W. J. O'NEILL, master mechanic of the Chicago, Rock Island & Pacific, at Shawnee, Okla., has been appointed mechanical superintendent of the Second district, with office at El Reno, Okla., succeeding R. L. Stewart, deceased.

E. S. PEARCE has been appointed assistant mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis at Beech Grove, Ind. Mr. Pearce graduated from Purdue University as a mechanical engineer, and then entered the machine department of Jos. T. Ryerson & Son, Chicago. He got his first railway experience in the motive power and maintenance of way departments of the Norfolk & Western Railway at Portsmouth, Ohio. For the last two years he has been engaged in special work in the motive power department of the Cleveland, Cincinnati, Chicago & St. Louis, which position he leaves to accept his new appointment.

F. P. PFAHLER has been appointed motive power inspector of the Baltimore & Ohio at Baltimore, Md.

L. K. SILLCOX has been appointed mechanical engineer of the Illinois Central in charge of car work. Mr. Sillcox was born April 30, 1886, at Germantown, Pa., and was educated at Trinity School, New York, and the Mechanical and Electrical Institute of Brussels. He entered the High Bridge shops of the New York Central as an apprentice in 1903, leaving there in 1906 to go to the McSherry Manufacturing Company, at Middletown, Ohio. In 1909 he resigned from that company as assistant shop superintendent. He was then made shop engineer of the Canadian Car & Foundry Company at Montreal, leaving in 1912 to become chief draftsman of the Canadian Northern, which position he resigned to go with the Illinois Central.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. BUTLER has been appointed assistant master mechanic of the Cleveland, Cincinnati, Chicago & St. Louis at Bellefontaine, Ohio.

FRANK S. COOPER has been appointed general foreman of the locomotive department of the Baltimore & Ohio at Newark, Ohio, succeeding J. T. Gethens, promoted.

OSCAR CULBRETH has been appointed road foreman of engines for the Cairo division of the Cleveland, Cincinnati, Chicago & St. Louis at Mt. Carmel, Ill.

G. K. GALLOWAY has been appointed assistant master mechanic of the Baltimore & Ohio, at Glenwood, Pa.

J. T. FLAVIN, master mechanic of the Chicago, Indiana & Southern at Gibson, Ind., has been appointed master mechanic of the New York Central at Elkhart, Ind., succeeding M. D. Franey. He will have charge of the fourth district.

P. L. DRESCHER has been appointed master mechanic of the Evansville & Indianapolis with headquarters at Terre Haute, Ind. Mr. Drescher was born in New York City on July 24, 1868. He received a high school education and entered railroad service in March, 1888, as a machinist with the Louisville, Evansville & St. Louis, now a part of the Southern Railway. After serving 10 years in this capacity he became machine shop foreman and in April, 1901, was appointed general foreman at Princeton, Ind. In July, 1902, he was transferred to Louisville, Ky., as general foreman, serving there until May, 1904, when he left railroad service to engage in business at Princeton, Ind. In September, 1906, he entered the service of the St. Louis, Iron Mountain & Southern as division foreman at McGehee, Ark. A year later he left this road to become roundhouse foreman on the Chicago & Eastern Illinois at Villa Grove, Ill., in which capacity he served until April, 1911, when he was appointed general foreman at Villa Grove. He left the service of the Chicago & Eastern Illinois in May, 1914, subsequently going with the Big Four at Mt. Carmel, Ill., where he remained until his recent appointment as master mechanic of the Evansville & Indianapolis.

P. L. Drescher

P. C. MOSHISKY, whose appointment as master mechanic of the Rio Grande Southern at Ridgway, Colo., was announced in these columns last month, was born on December 27, 1883, at Marysville, Kan., and was education in the public schools of his native state and in the Marysville Normal College. In 1901 he entered the service of the Denver & Rio Grande in the stationery department and later served in the purchasing agent's office. In 1904 he started serving an apprenticeship as a machinist with the same company, also taking a course in mechanical drawing. He was later employed as a machinist on the Colorado & Southern and in the United States reclamation service on the Gunnison Tunnel. In 1909 he entered the service of the Rio Grande Southern at Ridgway, Colo., as a machinist and in April, 1910, was appointed enginehouse and shop foreman at that point. In

P. C. Moshisky

September, 1911, he was appointed general foreman at Durango, Colo., and in March, 1916, he was appointed master mechanic of the Rio Grande Southern at Ridgway, Colo.

J. T. Gethens, who has been general foreman, locomotive department, of the Baltimore & Ohio, at Newark, Ohio, has been appointed assistant master mechanic at Baltimore, Md.

CAR DEPARTMENT

H. E. Pierce has been appointed general car foreman of the Illinois Central at Weldon passenger yard, Chicago, succeeding M. H. Long, deceased.

E. Opie has been appointed car foreman of the Grand Trunk Pacific at Endako, B. C., succeeding H. Saunders, transferred.

H. Saunders, formerly car foreman of the Grand Trunk Pacific at Endako, B. C., has been appointed car foreman at Biggar, Sask., succeeding H. E. Jell, who has left the company's service.

H. J. White, heretofore supervisor of car work of the Canadian Northern at Toronto, has been appointed general car foreman of the National Transcontinental at Cochrane, Ont., with territory from Quebec, Que., to Graham, Ont.

SHOP AND ENGINE HOUSE

H. E. Bennett has been appointed superintendent of shops of the Chicago, Terre Haute & Southeastern at Bedford, Ind.

E. G. Cromwell has been appointed general foreman of the Baltimore & Ohio at Cumberland, Md.

J. Honan has been appointed locomotive foreman of the Grand Trunk Pacific, at Calgary, Alta., succeeding F. Lozo.

F. J. Lozo, formerly locomotive foreman of the Grand Trunk Pacific at Calgary, Alta., has been appointed locomotive foreman at Wainwright, Alta., succeeding W. W. Yeager, transferred.

H. Walker, heretofore night locomotive foreman of the Canadian Pacific at Schreiber, Ont., has been appointed locomotive foreman at White River, Ont., succeeding F. H. Hetherington, who has enlisted for active service.

PURCHASING AND STOREKEEPING

I. H. Harsh has been appointed purchasing agent of the Duluth, South Shore & Atlantic and the Mineral Range, with office at Duluth, Minn., succeeding P. W. Brown, who has retired from service.

H. A. Spiers, formerly fuel agent of the Canadian Pacific at Vancouver, B. C., has been appointed assistant storekeeper there.

OBITUARY

James F. Walsh, who was general superintendent of motive power of the Chesapeake & Ohio from May 1, 1910, to July, 1912, died suddenly of apoplexy at the Hotel Roanoke, in Roanoke, Va., on April 13. He was born in March, 1857, at Cleveland, Ohio, and began railway work in 1871 on the Cleveland, Columbus, Cincinnati & Indianapolis, now a part of the Cleveland, Cincinnati, Chicago & St. Louis. From 1871 to 1892 he was consecutively apprentice, locomotive fireman, locomotive engineman and shop foreman. Mr. Walsh left railway work in 1892 to become mechanical expert for the Galena Oil Company, but returned to railway service 10 years later as superintendent of motive power on the Chesapeake & Ohio. In May, 1910, he was promoted to general superintendent of motive power at Richmond, Va., and on July 1, 1912, retired from the active duties of that office, but later served in a consulting capacity on the same road. At the time of his death Mr. Walsh was on a business trip to Roanoke for the Galena Oil Company.

SUPPLY TRADE NOTES

The main offices of the S. K. F. Ball Bearing Company have been moved from New York to Hartford, Conn.

The Baldwin Locomotive Works has moved its New York office from 50 Church street to the Equitable building, 120 Broadway.

The Robinson Connector Company has removed its office from New Haven, Conn., to the works at Branford, which is a suburb of New Haven.

The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, has opened a branch sales office at 416 Citizens' Building, Cleveland, Ohio, in charge of Charles E. Newell.

The Pressed Steel Car Company and the Western Steel Car & Foundry Company removed their Chicago sales offices from the Old Colony building to 425 Peoples Gas building on April 15.

M. D. Franey, master mechanic of the New York Central at Elkhart, Ind., has resigned to become superintendent of the Erie plant of the American Brake Shoe & Foundry Company, Mahwah, N. J.

Carleton D. Sperry, up to December, 1915, editor of the Railway Electrical Engineer, and since then with the B. F. Goodrich Company, Akron, Ohio, has entered the railway sales department of the company.

J. E. M'Lain, district sales manager of the Cambria Steel Company at Pittsburgh, has also been appointed manager of sales in that district for the Worth Brothers Company and the Midvale Steel Company, with offices at 1812 Oliver building.

G. I. Evans, formerly mechanical engineer, shop superintendent at Montreal, and later district master mechanic at Toronto for the Canadian Pacific, has been made general manager of the Imperial Iron & Steel Works, with headquarters at Collingwood, Ont.

E. S. Cullen, who has been associated with the Niles-Bement-Pond Company as representative for a number of years, has left the services of that company, and has established the E. S. Cullen Machinery Company, with office in the Leader-News building, Cleveland, Ohio, to deal in machine tools and locomotive cranes.

W. D. Smyth, district sales manager of the Cambria Steel Company at Cleveland, Ohio, has also been appointed manager of sales for the Cleveland territory of the Midvale Steel Company and the Worth Brothers Company. The three separate offices now maintained by these companies will be combined June 1 in new offices in the Swetland building.

Clifford J. Ellis, who has for many years been sales manager for the Cambria Steel Company at Chicago, has been appointed sales manager for the Midvale Steel Company, in charge of sales in that territory for the Midvale Steel Company, Cambria Steel Company and Worth Brothers Company in their combined relations.

The following have been elected directors of the Midvale Steel & Ordnance Company: John C. Neale, vice-president and general manager of sales of the Cambria Steel Company; E. E. Slick, vice-president and general manager of the Cambria Steel Company, and William B. Dickson, secretary and treasurer of the Midvale Steel & Ordnance Company.

Thomas Dunbar, manager of the mechanical department of the Pullman Company, Chicago, Ill., has resigned. C. W. Pflager, assistant to the manager of the mechanical department, has been appointed supervisor of the repair shops. Those officers of the construction department, who formerly

reported to Mr. Dunbar, will now report directly to Le Roy Kramer, vice-president.

Richard Brinsley Sheridan, general manager of the Brown Hoisting Machinery Company, Cleveland, Ohio, has resigned to become one of the executives of the American International Corporation, which recently purchased the Allied Machinery Company of America. He has been succeeded by A. C. Brown, assistant manager and vice-president of the Brown Hoisting Machinery Company.

The Vulcan Brake Shoe & Equipment Company was incorporated in Delaware, April 3, 1916, with an initial capital of $1,000,000. The company will engage in the manufacture of brake shoes and grey iron castings. It will have offices in the Equitable building, 120 Broadway, New York, and works at Baltimore, Md. Its officers are: W. H. McDonough, president; Edward Barrett Smith and R. M. Brower, vice-presidents; F. W. Grant, secretary and treasurer. Robert N. Hill is engineer of tests, and H. K. Schoenheiter, superintendent of the works.

W. H. McDonough has been elected president of the Vulcan Brake Shoe & Equipment Company. Mr. McDonough was born in New York City, and was educated at the College of the City of New York. He is a lawyer by profession, but has been in active commercial work for some years. Until recently he was associated with the American Brake Shoe & Foundry Company, and was an officer in several corporations controlled by interests connected with that company.

W. H. McDonough

Edward Barrett Smith, who has been elected vice-president of the Vulcan Brake Shoe & Equipment Company, was born in New York City, and until his resignation on March 31 had been with the American Brake Shoe & Foundry Company and its predecessors, the Ramapo Foundry Company and the Ramapo Iron Works, for twenty years. When he left to become associated with the Vulcan Brake Shoe & Equipment Company he was in the sales department, specializing in the sale of brake shoes to electric railways and for the export trade.

E. B. Smith

R. M. Brower, who has been elected vice-president of the Vulcan Brake Shoe & Equipment Company, was born in Riverton, N. J., and was associated with the American Brake Shoe & Foundry Company for eight years. For a number of years he was in the motive power department of the Central of New Jersey. During his first two years with the American Brake Shoe & Foundry Company he was engaged in special work in the engineering and testing departments, and at the time of his resignation on March 31 was connected with the sales department, specializing in the sale of brake shoes to steam railroads.

R. M. Brower

F. W. Grant, who has been elected secretary and treasurer of the Vulcan Brake Shoe & Equipment Company, was born at East Windsor Hill, Conn. He was with the American Brake Shoe & Foundry Company for nine years. Prior thereto he was connected with the Pope Manufacturing Company for eight years. He entered the services of the American Brake Shoe & Foundry Company in March, 1907, and served successively as chief clerk of the Mahwah (N. J.) plant, chief clerk at the Chicago Heights (Ill.) plant, assistant comptroller in charge of the cost department, and assistant to the vice-president in charge of sales and accounting.

F. W. Grant

Robert N. Hill, who has been elected engineer of tests of the Vulcan Brake Shoe & Equipment Company, was born in Ontario, Can. He graduated from Cooper Union, New York City, with the degree of electrical engineer, afterwards taking a post-graduate course in mechanical engineering. He was for several years in the engineering department of the Interborough Rapid Transit of New York City, and was five years in the testing and engineering department of the American Brake Shoe & Foundry Company.

H. K. Schoenheiter, who becomes superintendent of the works of the Vulcan Brake Shoe & Equipment Company, was born in St. Paul, Minn. He learned the trade of foundryman and machinist with Henry H. Ormes & Sons, of Minneapolis, with which company he was connected for 15 years, seven years of which time he was superintendent of the works. The business of this firm was later purchased by the American Brake Shoe & Foundry Company, and became known as the Twin City plant. He remained there in charge as superintendent for two years, and five years ago was transferred to the company's largest plant at Mahwah, N. J., where he remained until he severed his connection with the organization.

The Acme Supply Company announces the appointment of Franklin M. Nicholl as sales representative, with headquarters at the general sales office, Steger building, Chicago, Ill. Mr. Nicholl has been for the last seven years eastern and Canadian sales representative of the Dayton Manufac-

turing Company. Previous to that he was for five years sales representative of the O. M. Edwards Company, and for a short period was also salesman for the Curtis Truck Company.

At the annual meeting of the American Tool Works Company, held at Cincinnati, March 30, the following officers were elected: J. B. Doan, president, succeeding the late Franklin Alter; Robert S. Alter, vice-president and foreign manager; Henry Luers, secretary and treasurer. The directors are as follows: J. B. Doan, Robert S. Alter, L. E. Voorheis, Clifford Wright and Walter Hofer.

Leigh Beekman Morris, for the past four years New York district sales manager for the Cambria Steel Company, was on April 1 made manager of sales in the New York territory for the Cambria Steel Company, the Midvale Steel Company and Worth Brothers Company. It is expected that the offices of the three companies will be consolidated in New York City, possibly in the City Investing building, 165 Broadway, where the Cambria offices are now located. Mr. Morris has been connected with the sales organization of Cambria Steel Company for about 23 years.

B. A. Clements, western railroad representative of Worth Brothers Company at Chicago, has left that position, and has been elected vice-president of the Rome Merchant Iron Mills. Mr. Clements was born at Indianapolis, October 3, 1877, and after graduation from the public schools of Centralia, Ill., entered the service of the Illinois Central as messenger boy. From 1891 he served successfully as clerk and stenographer to the roadmaster and superintendent of the Chicago and St. Louis divisions until July, 1898, when he became secretary to the general passenger agent of the Michigan Central at Chicago. In 1899 he returned to the Illinois Central as secretary to the general superintendent of transportation, and from 1902 to 1904 was chief clerk to the general manager. From 1906 to 1909 he was chief clerk to the vice-president in charge of operation, when he was appointed general agent, operating department, reporting to the president. In 1910 Mr. Clements left the Illinois Central to accept the position of western railroad representative of Worth Bros. Company, with headquarters at Chicago. As vice-president of the Rome Merchant Iron Mills, he will have headquarters at 30 Church street, New York.

B. A. Clements

The Universal Arch Company has been incorporated for the manufacture and sale of locomotive arch fire brick and other railway equipment. The company has established its general offices in the McCormick Building, Chicago, directly in charge of William Smith, president, formerly master mechanic of the New York Central, J. B. Kilpatrick, vice-president, formerly district mechanical superintendent of the Chicago, Rock Island & Pacific, and John H. Cavender, vice-president and treasurer. The company has placed contracts with leading fire brick manufacturers. The types of locomotive arch fire brick which the new company has placed upon the market have been passed upon and accepted by the Western Railroad Association

CATALOGUES

Pulverized Fuel.—The United Combustion Company, 30 Church street, New York, in its first bulletin issued under date of March 1 describes the company's pulverized fuel feeder for stationary service.

Machine Tools.—Bulletin No. 140 recently issued by the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio, is a manual for the operator's guidance in using Lodge & Shipley engine lathes and attachments. It gives brief descriptions of the different parts of the lathe, instructions for operating, suggestions for handling work, grinding tools, etc.

Pumps.—The A. S. Cameron Steam Pump Works, New York, has recently issued bulletins Nos. 154 and 110. Catalogue 154 is devoted to Cameron centrifugal pumps. Sectional views are used to illustrate both the single and double suction open impeller types, and the booklet gives tables of capacities, speeds and horse powers. Catalogue 110 covers the Cameron line of duplex pumps, including both piston and plunger types, with single and compound steam cylinders for general service, boiler feeding, tank service, water works, hydraulic elevators, automatic pumps and receivers, brewery, quarry and mining work. The catalogue is well illustrated and also contains tables of sizes and capacities.

Corrosion Resistance of Copper Steel.—The American Sheet & Tin Plate Company, Pittsburgh, Pa., has issued a 22-page booklet entitled, "Research on the Corrosion Resistance of Copper Steel," by D. M. Buck, metallurgical engineer, American Sheet & Tin Plate Company, Pittsburgh, and J. O. Handy, director of laboratories of the Pittsburgh Testing Laboratory, Pittsburgh, describing the results secured from elaborate tests on full size sheets of copper-steel alloy. These tests show that steel or iron containing copper shows greatly increased corrosion resistance when exposed to atmospheric conditions, the most effective amount of copper for this purpose being approximately 0.25 per cent. This book is valuable to any one interested in this subject.

Alloys.—The Titanium Alloy Manufacturing Company, Niagara Falls, N. Y., has recently issued, through its bronze department, a booklet bearing the title: Titanium Aluminum and other standard bronze castings. This booklet describes over 30 alloys made by the company for various uses. In the case of each alloy there are given the approximate composition, the service for which the bronze is best adapted and the physical properties, as well as etchings showing each alloy magnified 20 and 200 diameters. A number of pages in the book explain how the various tests were made and contain tables showing: The electro-chemical series of the elements; the resistance and relative conductivity of various metals and alloys; physical constants of the more common metallic elements, etc.

Fire Extinguishers.—The railroad number of the Firefly issued by the Pyrene Manufacturing Company, New York, under date of February, 1916, shows in a striking way the necessity for fire extinguishers in railway cars, stations, warehouses and similar places. The articles are illustrated with pictures showing fires in and the resulting destruction of railway property, the point being made that in nearly every case the fire could easily have been extinguished before it had become too big had fire extinguishers been available. It is noted, moreover, that in each of these cases the value of the property destroyed was many times the cost of a complete installation of extinguishers. The advantages of Pyrene extinguishers are given in detail and mention is made of the installations in railway service and of instances in which the Pyrene apparatus was put to good use by being at hand when the fire started.